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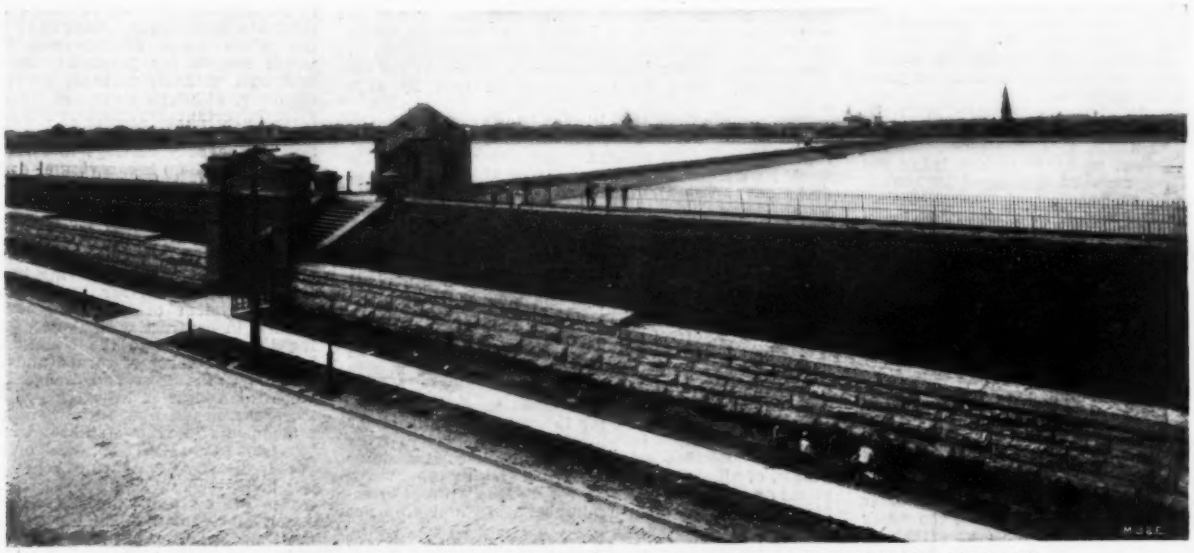
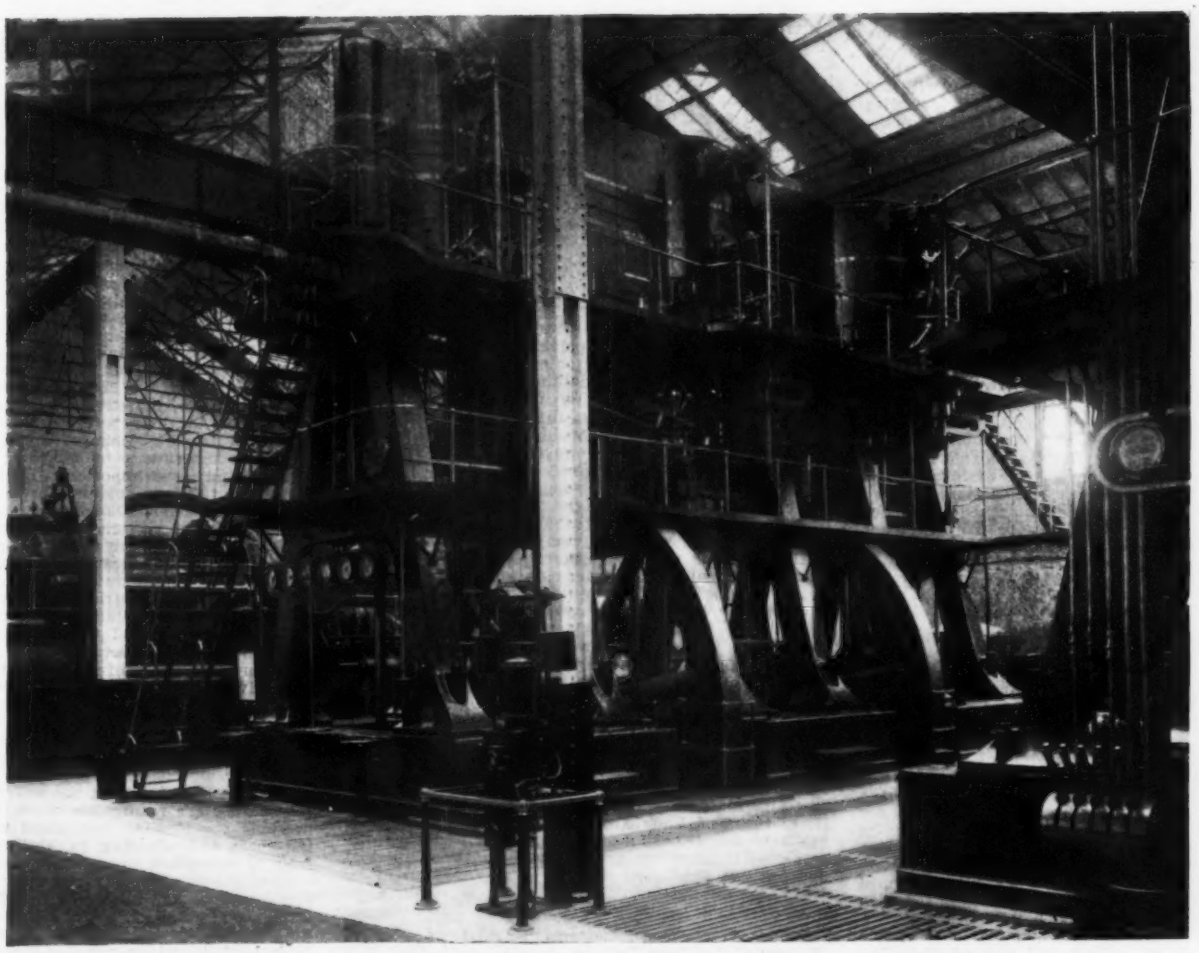


BUFFALO WATER WORKS—PROSPECT RESERVOIR—CAPACITY, 116,000,000 GALLONS.



BUFFALO WATER WORKS—LAKE ERIE ENGINE, 30,000,000 GALLONS CAPACITY.

THE WATER WORKS SYSTEM OF THE PAN-AMERICAN CITY.

But few cities are as well governed as Buffalo. It is one of the best paved cities in the United States, having more than 4,000,000 square yards of asphalt pavement alone—almost as much as New York city. Its system of parks and boulevards is unexcelled, and when the scheme is fully developed it will have few equals. The Health Department, judged from the standpoint or organization, administration and equipment, is without a peer. Its public utilities—including the gas, electric lighting, water and street railways—are up-to-date, comparatively well managed, and, taken together with the commercial *esprit de corps*, lend a metropolitan air seldom found in a town of its size. Its fire and police departments are well organized, equipped and efficient. For these reasons it will be advisable for the city official and others interested in municipal affairs to allow at least one day in ten to investigate these excellent civic features.

The city was served by a private water company, with varying success, up to 1868, when the citizens became so dissatisfied with the work of the corporation that an act of the Legislature was secured authorizing the city to construct and maintain its own water works system. At this time $705,000 were paid for the plant of the private corporation, which consisted of about 34 miles of pipe, varying in size from a 3-inch main to a 24-inch main; two pumping engines with an aggregate capacity of 10,000,000 gallons per day; one reservoir holding 11,000,000 gallons; and a tunnel 330 feet long and 4 feet in diameter. The city was exceedingly generous to the private company, for a careful estimate made at the time showed that the plant could be duplicated for $500,000.

To-day the system is a giant as compared with the plant of 1868. The distributing mains cover an area of 25,000 acres with a net-work of iron pipes, ranging in size from the smallest up to 48 inches, being 490 miles in extent. From a nominal value of $705,000 it has grown to be worth $9,000,000.

The distributing reservoir, finished in 1893, is located in about the center of the city, covering an area of about 20 acres, having a capacity of 116,000,000 gallons. It has an elevation above the level of the water at the inlet pier of 116 feet, and above sea level of 694 feet.

The supply is inexhaustible, as the intake is located in the middle of the Niagara River within one mile of Lake Erie. The water is received from the river through two tunnels, one equivalent in area to a circle 6 feet and the other 9 feet in diameter. These tunnels run out into the river, at right angles with the bank, about 1,000 feet, and are 30 feet apart. They are unlined, having been hewn out of the solid rock. The inlet is protected by a pier of cut stone masonry, which was completed in 1874. The tunnels connect with the inlet by shafts, one measuring 6 feet and the other 6 by 12 in diameter. The average depth of the water at the inlet is 15 feet, and the lower part of the intakes are located 6 feet above the bottom of the river. The current varies from 6 to 14 miles an hour, depending somewhat upon the velocity of the wind.

During the winter season much trouble is experienced with ice, as large fields are constantly passing down the river from Lake Erie. For this reason the intakes have to be protected with steel shields, which project 2 feet from the pier and extend down within 2 feet of the river bottom. The shields are provided with gates opposite the intakes, which are closed when the ice is running, when the supply is taken from the bottom of the shields. Ordinarily this is sufficiently effective, but there are times when the river is filled with "slush ice," extending down to the bottom of the river. Then the ice enters the intakes and shafts in large quantities. Ice elevators are maintained at both the intake pier and at the shore end of the tunnels, and there are times when it requires the combined efforts of all means, human and mechanical, connected with this portion of the service to keep free from anchor ice.

The purity of Buffalo's water supply, all things considered, compares favorably with that of other cities which do not employ filters. The bacteriologist makes a daily examination of the water to determine the number of micro-organisms in the supply. By this means the presence of bacterial flora in dangerous quantities is readily detected and the public warned. For instance, in 1894, when Buffalo had an epidemic of typhoid fever, the bacteriologist discovered the danger and warned the health commissioner before the epidemic broke out. An abnormal amount of pollution was discovered and the health commissioner found, upon investigation, that, on account of some emergency at the pumping station, an old and abandoned intake had been opened and water from the Buffalo ship canal was pumped into the city mains. The old intake was sealed and abandoned forever, but not before a large amount of pollution had been pumped into the distributing system. Although every precaution was taken to prevent evil results, it was without avail, as the epidemic broke out four days later; but it is undoubtedly true that a more serious trouble was prevented by the warning from the bacteriologist.

The pumping station of this system of water works is the largest in the world. It has a daily capacity of 187,000,000 gallons, which is almost equal to the flow of the river Thames! To drive this immense volume of water through a system of mains 490 miles in extent requires the use of a proportionately large horse power. The total capacity of the station, reckoned in horse power, is 6,880. The power is developed by thirty-four horizontal return-flue boilers, fitted with smokeless furnaces.

There are three Worthington pumps, one with a capacity of 12,000,000 gallons and two of 20,000,000 gallons each; four Holly pumps, one with a capacity of 15,000,000 gallons and three of 20,000,000 each; and two Lake Erie pumps, each with a capacity of 30,000,000 per day.

The Worthington and Holly pumps are of the horizontal compression type and the Lake Erie, triple expansion. A more detailed description of one of the largest pumps cannot fail to be of interest. The last of the two 30,000,000 gallon pumps was installed at an expense of $64,250, and is almost an exact counterpart of the other. Its principal dimensions are as follows:

Number of steam cylinders	3	
Diameter of the high-pressure cylinder	37	inches
Diameter of the intermediate cylinder	63	inches
Diameter of the low-pressure cylinder	94	inches
Diameter of the two piston-rods	5	inches
Stroke of the engine	60	inches
Number of pumps	3	
Diameter of each plunger	42	inches
Diameter of each of the four plunger-rods	5.5	inches
Diameter of air-pump	33	inches
Number of gallons of water pumped by each revolution	1,079	
Capacity of engine in 24 hours	30,000,000	gallons
Number of valves in pump chambers	1,188	
Diameter of valves	4.75	inches
Diameter of each of the two flywheels	20	feet
Weight of flywheels, each	32	tons
Diameter of discharge pipe	48	inches
Horse power of engine	1,200	

The average daily amount of water pumped during 1900 amounted to 109,371,992 gallons, or a per capita consumption of 310 gallons per day. This is another unique feature of the plant, but not to its credit, for it makes the city the most wasteful in the world.

There is no guess work about the amount of water pumped at this immense pumping station for it is accurately measured by a 48-inch Venturi meter, made by the Builders Iron Foundry, of Providence, R. I. The register of this gigantic meter is located in the engine room, where its record can be read by anyone.

Late returns from the cities and towns of the United States make the average consumption of water, per capita, per day, 75 gallons. This shows that Buffalo wasted water in 1900 at the rate of 82,810,945 gallons every day! Based on the rate at which London uses water—30 gallons per capita per day—this waste would supply a city with a population of 2,760,365. This undesirable state of affairs is brought about by the interference of the people, who will not permit the plant to be run upon a business basis. Usually when a plant which is operated by a city is mismanaged, the fault is charged to the administration, but in this case the people are the direct cause of this deplorable condition. Superintendent Illig has repeatedly urged that he be authorized to gradually introduce the use of meters on the domestic service, but without avail. It has been shown that thousands of small consumers permit their water to run the year through; in the summer to keep it cool and in winter to keep the pipes from freezing. Besides this there are numberless other people, of all classes, who permit a leaking pipe, water closet or other fixture to go for months without attention, as it saves them a plumber's bill and does not increase their water rent.

The superintendent, in a communication to the commissioners of the board of public works, some weeks ago, cited, among other arguments favoring the use of meters, the experience of Detroit. "The use of meters introduced in Detroit, in 1886," said Mr. Illig, "has enabled that city to hold its pumpage at a stationary figure for ten years, although its population has increased 75,000. This indicates a fixed consumption for ten years, with a 56 per cent increase in population and a per capita decrease from 203 to 130 gallons. This was accomplished by metering about 5,000 consumers out of a total of 49,000."

The pumping station is lighted by its own electric light plant, which was installed and equipped at a total expense of $9,151. There are 46 arc lamps of 160 candle power each and 450 of 16 candle power each. The dynamos were furnished by the Ridgeway Dynamo and Engine Company, of Ridgeway, Pa.

While the plant has never been a startling success, from a municipally owned and operated standpoint, nevertheless it is quite true that the people have received a better and more liberal service than would have been the case under private ownership. There are abundant opportunities for economizing, which, if the people would only permit him, would be improved by Superintendent Illig. By putting into practice some of the needed reforms, the use of meters being the most urgent and salutary in possible good results, the plant might be made one of the models of the country. But until the newspapers lend a hand in throwing some needed light on the practical value of meters it is not at all likely that the water works of the city of Buffalo will occupy any more exalted position that at present for many years to come.

Although the present capacity of the plant is far beyond the real needs of the city, yet it will soon be unable to meet the growing demand made by the immense waste. For this reason a second pumping station is contemplated, for which plans have been prepared and approved, with a minimum capacity of 200,000,000 gallons per day. It will be located on the shore of Lake Erie with its intake one mile from shore, connected by a tunnel thirteen feet in diameter.

In comparison with the Boston water works, although the population of Boston is twice that of Buffalo, the amount of water consumed in Buffalo is more than twice the amount used in Boston. The cost and revenue of the Boston water works are four times those of Buffalo, while the operating expenses are only doubled.—For our engravings and the foregoing particulars we are indebted to the Municipal Journal and Engineer.

Proposed German Customs Regulations.—Consul Warner writes from Leipzig, June 18, 1901, that it is reported that the Reichstag will pass a law compelling American exporters to Germany to make out invoices covering the shipments, these invoices to be authenticated by the German Consul in the United States in whose district the goods were produced. It is alleged that such a course will help the officials in perfecting the statistics of the imports from the United States, and will also throw another obstacle in the way of American exports to Germany.

AMERICAN LOCOMOTIVES IN ENGLAND.—V.

By A Locomotive Engineer.

In earlier communications I have dealt with the question of American locomotives in this country in comparison with their English competitors. In my last chapter I dealt with the main features in the designs of American locomotives in their relation to British designs. In this communication I purpose contrasting the details of American and English locomotives, and the materials used in their construction in relation to the question of first cost, and will then bring the subject to a close with some comments on the "engine-off-the-peg" remarks of the chairman of the Midland Raiway Company in their bearing on the question of competition between English and American locomotive makers in countries abroad.

It will be remembered that in my last chapter there was arrived at by a process of elimination the fact that nothing fundamental remained to the American design except the bar frame, with its subservient method of uniting the cylinders together, all other features of the American engine being simply matters of dimensions, which were equally open to English locomotive makers to adopt, if the necessity for doing so existed.

As regards details, it is obviously impossible to go minutely into all of them within the reasonable limits of a communication of this kind; but let me begin by referring to those which arise out of the American practice of using bar frames, and which, as regards the question of first cost, are of no inconsiderable importance. They are the only details in the whole range of American locomotive practice which can, in my judgment, be regarded as saving first cost without, perhaps, too great a sacrifice of efficiency, although there are, even as regards them, some important drawbacks. I allude to the mode of attaching the cylinders to one another by a prolongation of the body castings to form a central jointing. Undoubtedly here is a saving of cost as compared with the use of a built-up wrought-iron—or steel—plate and angle box-stay, or any equivalent arrangement of flanged plate stays to unite rigidly the frames at the front end of the engine, as is the practice in this country where outside cylinders are used. To this must be added, too, the saving in first cost, resulting from what I may, for brevity, call the "lugs and wedge" system of attaching the cylinders to the frames, in contrast with the English method of bolting the cylinders to the frames by flanges, secured by a large number of turned and tightly-driven bolts. Admitting the lugs and wedge method to be sufficient for a time to keep the cylinders from working loose, there can be but little margin of surface in these attachments in view of the narrowness of the widest bar frames used—say 4 inches or 4½ inches—as compared with the large surface represented by the numerous bolts used in English practice. The former may suffice during the comparatively short life of the American locomotive which even its most ardent advocates assign to it; but it is very questionable whether it would satisfactorily withstand the see-saw strains to which the cylinder attachments are subjected during the much longer period that British-made locomotives are expected to endure, and do endure as efficient and economical machines. Granting all the above-named points in favor of the American system of bar frames and cylinder attachments, they are got at the cost, named in my former article, of a loss of, say, 6 inches in the width of the fire-grate, whereby the engine is cramped in a vital part. But there is another point in which the American method of attaching the cylinders to one another is at a disadvantage compared with the English method. It compels the adoption of the circular smoke-box of comparatively small diameter, and a circular tube plate attached to the boiler barrel by an internal flange, in contrast with the English method of attaching the smoke-box tube plate to the barrel by means of an external angle ring, with the rivets placed at a considerably greater radius than the inside of the barrel. As a result of its greater diameter, the tube plate is more free to adjust itself to the expansions and contractions of the tubes, whereby the internal stresses on the plate, which tend to cause grooving, are minimized, and the life of the tube plate prolonged. In addition to this, the stresses on the tubes themselves, which lead to their "creeping" in the fire-box tube plate and causing leakage, are diminished; and it is almost superfluous to add that these are matters of more and more importance in proportion as boiler barrels of the large engines used now-a-days become longer and longer. It may be urged, I am aware, that the American practice of using iron or steel tubes, as against those of brass or copper, employed, as a rule, in British-made engines, renders the American form of tube plate practicable without its undergoing any injurious strain on account of the amount of expansion being relatively less in the case of tubes made of iron or steel than when made of brass or copper. This, however, obviously raises the question of materials, as used in American and English engines respectively—a question of primary importance in relation to the question of first cost and durability, with which, as I have said, I purpose dealing in due course—and all I need remark in the meantime is, as I have pointed out in my last communication, that if iron or steel tubes are suitable for the conditions as regards the quality of the water, etc., under which the engines are required to work, there is nothing to preclude the English locomotive makers from adopting them and adopting in like manner the cheaper form of smoke-box and tube plate.

Having said all that seems necessary to say on this occasion about the main features of the bar frame and its concomitants, let us turn to a few of the details of construction in American locomotives which are typical of American practice, in contrast with that of British makers. Take, to begin with, the axles. The English practice is to turn the wheel seats to a larger diameter than the journals to avoid the risk of their breaking within, or at the point of junction with, the wheel boss, where an incipient crack cannot be seen, and to make all collars out of the solid, with well-rounded corners at the ends of the journals and elsewhere to minimize the risk of breakages. The American practice is to use practically parallel

round bars with the wheel seats not larger, and often less in diameter, than the journals, and to shrink on hoops for collars. As regards the axle-boxes, the English practice is to make those for the coupled axles of wrought iron, with the rubbing surfaces case-hardened, and fitted with substantial brasses provided with ample end flanges to minimize the wear caused by side pressure in rounding sharp curves, while the American practice is to make the axle-boxes of cast iron, fitted with brasses having less bearing surface on the journals than is usual in this country, and affording comparatively little end surface. Again, the English practice is to give large surfaces to take the alternating fore-and-aft pressure of the axle-boxes of the coupled axles by attaching to the frames broad horn-blocks of steel or case-hardened wrought iron, while the usual American practice is to guide the axle-boxes by forks of no greater width than the frames, and without the intervention of any specially hard material. And, in passing, I may mention, as a point illustrating the references I made in an earlier part of my article to the inferior oiling appliances in American engines, namely, that the American axle-boxes, as usually made, have no oil-siphoning arrangement such as English engines are provided with, but have merely recesses in the tops of the boxes, which are filled with waste or other similar material on which the oil is poured to saturation, and which trickles, sometimes too fast and sometimes too slowly, according to the degree of saturation, onto the journals through holes bored in the bottom of the recesses. It is currently reported that the axle-boxes of the American engines on the Midland Railway have given much trouble, and if the oiling appliances are in accordance with the usual American practice this is not to be wondered at, nor is it surprising that the oil bill is high in comparison with that for their British competitors.

Take next, by way of illustration, the motion work of an American engine. The bosses for the pins of the expansion links, lifting links, eccentric rods, and reversing connections are narrow and deficient in wearing surface, and the pins themselves are short and small in diameter compared with what would be provided in English-made engines of equal power. All this means saving in first cost of material and machine work, but at the expense of durability and upkeep. The like may be said of the wearing surfaces of the coupling rods and other parts of the steam machinery of the American engine. Again, the eccentrics are made solid; this saves considerable cost in making them, but it necessitates their being slipped on the axle before the wheels are forced on; and if they happen to work loose—which is not an unknown experience by any means—there is no satisfactory remedy but to pull off the wheels and put on new and better fitting solid eccentrics, or to break off the faulty eccentrics and replace them with jointed ones, in accordance with the more expensive, but more satisfactory English method, inasmuch as it admits of a thoroughly satisfactory dead fit being insured to start with. The usual American eccentric strap is not fitted with a liner, which can be readily replaced when required to meet wear as is usual in English practice, and the American method of attaching the straps to their rods sidewise, by means of bolts in oblong holes, to admit of adjustment in the length of the rods, is certainly a cheap method, but is very inferior to the English plan of uniting the rods to the eccentric straps by lugs held together by direct-acting bolts, the faces of the lugs being adjusted in the first instance to the exact length of rod required, a plan which readily admits of variation in the length of the rod by inserting a thicker or thinner packing, as circumstances may afterward require. In the American method any permanency in the length of an eccentric rod is dependent wholly on the friction between the butt end of the rod and the lug of the eccentric strap remaining sufficient.

I think I have referred to sufficiently numerous instances of the methods of cheapening first cost adopted by American locomotive engineers in designing the more important parts of their engines; but before leaving this part of the subject I would briefly refer to one or two more of the many other details which exemplify the same thing. Take, for instance, the bogie. I think one may say without hesitation that the bogies of American locomotives and tenders are, as a rule, and in comparison with those of English construction, inferior in a very marked degree as regards substantiality and durability, being made up of bent bars and paltry bolts and pins; while, as regards their principle of action, they have certainly nothing to recommend them in preference to the bogies of English engines. In fact, this "bent-bar, bolt-and-nut" style of construction is typical of American locomotive design throughout the engine. Similarly the details of the American tender will not bear comparison with those of British locomotives as regards either strength or durability. In both engines and tenders the joints and attachments of the brake gear, spring links, compensating beams, etc., are lacking in wearing surface in comparison with the like fittings in English-made engines. Moreover, these joints are case-hardened in English engines, while the usual American practice is to leave them unhardened. The brass work and boiler fittings of American engines are less substantial. The English practice is to rivet permanent "seatings" to the boiler for the attachment thereto of the numerous cocks and other boiler mountings by flanges secured by studs, which not only insure steam-tight joints, but admit of the ready removal and refixing of these fittings as often as occasion may require, without any change in their position relatively to the pipes and other unions with which they are connected. On the other hand, the usual American practice is to attach cocks and other fittings to the boilers by nozzles screwed direct into the boiler plates without any collar to screw up to. These nozzles are slightly tapered, which, no doubt, insures a tight fit to start with. But the chances of a leaky joint occurring if the fitting has to be removed and replaced at any time are obvious, unless the cock or other fitting is screwed further in than before, which will alter the position of its flanges or other unions relatively to the pipes they have to couple up to. As I have already remarked, all these methods go to keeping down first cost; but they obviously mean, sooner or later, the expenditure of extra time and money in maintenance and repairs.

Let me add one word before quitting this part of the subject. It is claimed by the advocates of American locomotive practice that no inconsiderable saving in the first cost of American engines is effected by dispensing with what they term the useless finish of non-essentials in locomotives made in this country. Well, no doubt American locomotive makers do save money by this means, but in ways which English locomotive makers would be somewhat ashamed of, because in their eyes the saving in cost is not commensurate with the slovenliness it indicates, nor in keeping with really high-class work in essentials. An American locomotive maker of even good standing will, for example, punch a large hole in a plate or reduce the size of a plate by punching, and leave the punch marks all round, provided only this slovenly finish is hidden from view by a splasher or some such covering; while an English locomotive maker would trim the edge of the plate under like circumstances. And in other ways the latter undoubtedly spends money in finish which his American competitor saves. There is another feature in respect of which the American locomotive maker saves money. American locomotive men seem to be quite indifferent to the symmetry and external appearance of their engines and tenders, and will tack on here, there, and everywhere any part or fitting as it may come in handiest, without apparently any regard for what I may term unity of design. In this way a good deal of money is saved in the drawing-office, which English locomotive men think well worth spending to give their engines and tender the appearance of being a harmonious and unified design. Mr. Charles F. Beyer early led the way in this matter. The locomotive "Dom Luiz," which his firm designed and constructed for the Portuguese government in 1862, and which was exhibited in the London International Exhibition of that year, was specially referred to in the Art Journal of that day as being notable for the beauty of its outline and its harmony of design. The fact is, the question of harmonious design and external finish of even non-essential parts is not so "superficial" as it may seem. A well thought-out design and good workman-like external finish of a locomotive or any other machine, goes hand in hand with good, sound, substantial work in the essentials. The sneer at overfinish is, in most cases, a pretext to cloak indifferent work in essentials. Our good friend "the superficial thinker" even would have some doubts about the internal qualities of a chronometer he was desirous of purchasing if it were offered him in a roughly-finished, ugly-looking case.—The Engineer.

THE BUILDING OF MODEL TENEMENTS.

ONE of the greatest problems that all of the large cities are called upon to solve is the housing of the poor. For years the subject was wholly neglected by the local authorities and left entirely to the real estate owners and builders. That attention is now generally given to the problem is due not alone to the general spirit of altruism, but to a realization that the old methods of housing the poor directly contributed to the spread of vice and pestilence. London and New York in particular have given attention to the subject, and the work accomplished by the various tenement house committees in this city is familiar. During the past few months a new and stringent tenement house law has been added to the statute books, and the plans for what is practically the first tenement house under the new law have just been filed with the Building Department in New York. This is for a new model tenement to be erected at Avenue A, 78th and 79th Streets, by the City and Suburban Home Company, an association of practical business men and philanthropists. The plans are by Herbert S. Harde and R. Thomas Short, who have spent several years in the study of economic planning and construction of improved model tenements. It was on plans furnished by them that the new tenement house law was based. Messrs. Harde & Short won the first prize out of 170 competitors in the recent competition instituted by the Tenement House Committee of the Charity Organization Society.

The present building will have the entire block fronting on the avenue, and will be six stories in height, of semi-fireproof construction. There will be 86 separate compartments of three and four rooms each, so that the building will shelter on an average fully 1,000 persons. When this is complete a second section will be built in the rear, fully as large as the first and separated from it by a 20-foot roadway. The cost of the first section, exclusive of the ground, is estimated at $180,000. The building will be attractive architecturally, and there will be nothing to suggest the repulsive tenement so common in the congested districts. The front will be of buff-colored bricks, with Indiana limestone and terra cotta trimmings. The entrance will be of polished colored granite. The vestibules will be wainscoted throughout with marble, and the floors of the entrance and the staircase halls will be of colored inlaid tiles. The public halls, which are responsible for so much vice in the ordinary tenements, will be done away with almost entirely, there being but one, and that on the first floor. There will be four main entrances and eight staircases. The latter will be inclosed in heavy brick walls and will have absolutely fireproof floors, stairs, doors, windows, and roofs. The aim is to have each compartment in itself a complete private home, with plenty of light, air, and ventilation. Each will have an entrance hall, private toilets, large combination kitchen and dining room, parlor and one or two bedrooms. The four-room apartments are to have private bathrooms. There will also be a number of tub and shower baths on the first floor. The huge building is so planned that there will be no interior vent shafts of any kind. All toilet rooms and staircase halls will have windows, the latter on each floor, and the living rooms will have from one to three windows opening directly on the street or yard or large open courts. Every apartment will be supplied with a gas range and the entire building, including the halls and staircases, will be heated by steam. Hot water will also be supplied to the tenants from the cellar without extra charge. In each kitchen there will be two white crockery washtubs, and the plumbing will be of the most improved kind. Dust chutes will lead from each apartment to the cellar, where there will be a special furnace for consuming the sweepings. In the cellar will also be a garbage room so ventilated that there will be no odor. In each private hall will be a refrigerator space with drainage to carry off the water. The roof will be of plastic slate, and the walls will be carried above it so it can be turned into a roof garden or play space for the children. The rent will be equal to one dollar for each room a week, and it will be collected weekly instead of monthly. On the ground will be nine stores, none of which will be rented for saloon purposes. One of them will be a large modern bakery.

The construction of this tenement is a purely business proposition, the same as the erection of the Mills Hotels. The City and Suburban Homes Company has found that structures of this kind yield a net return to the investors of fully 4½ per cent. We believe that one of the greatest achievements of the present century will be found in the line of the abolition of the slums and the decent housing of the poor. If this were all to be done as a matter of charity the need for it would be no less imperative, but if it can be made to yield a fair return for investors there is no question that countless millions of dollars will be available for the purpose. The only opposition that is being encountered is that of the grinding landlords of the old "double-decker" tenements, who do not wish to see their 15 or 20 per cent profits wiped out. Their protests will not be heeded. Aside from all sentiment of right and morality in the matter, the improvement will be welcomed in a business way by the readers of this magazine. The old tenements were flimsy in construction, while the new ones are to be honestly and solidly built. General use will be made of stone, not only for structural, but also for decorative purposes. The use of marble wainscoting is, of course, not essential in tenement house construction. But it is more durable, sanitary and satisfactory in every way than plaster and cheap substitutes, and the men who will be in charge of construction are not of the kind to cut down every possible penny in the effort to swell dividends. At the present time the tenement house problem has assumed momentous proportions only in the great cities. In few of the smaller cities are there what may be properly called slums. Still there is room for improvement in all of the cities, and when once the great centers have shown that they can successfully solve this problem, the smaller cities will fast follow in their lead. —Stone.

A KEROSENE OIL BLOWPIPE.

THIS blowpipe has been devised in order to utilize the combustion of kerosene oil for the production of a blowpipe flame suitable for glass-blowing and other purposes, so as to combine the advantages of a gas blowpipe while independent of a supply of gas. The need of such a blowpipe is obvious in a country like India, where gas is not always available, and where in many college laboratories not supplied with gas blowpipe work is necessarily limited to operations with the mouth blowpipe and spirit lamp.

At first it seemed possible to use one of the vegetable oils, such as cocoanut oil, by burning it in a modified form of glass-blower's "tallow lamp," but the tendency of all such oils to char at the temperature of the blowpipe flame renders them useless as a continuous source of heat, unless the wick is being constantly trimmed. As kerosene oil does not char, it was selected for this purpose; its combustion, however, in a lamp without a chimney requires special arrangements, if it is to give a solid, steady flame, easily regulated and completely under the control of the operator, and it was only after many unsuccessful attempts that a lamp was constructed which fulfills all the requirements of the case.

As it now stands, the blowpipe consists of a metal tube, 1½ inches long and ¾ of an inch in diameter, fixed at an acute angle above the oil holder, with which it is connected by a flattened tube or wick holder. A wick about 1 inch wide is used. The wick is protected and kept in its place by a tube of iron wire gauze, projecting beyond the wick on either side. The lower end of the metal tube is closed by a perforated cap, through the center of which the blowpipe jet passes. This is made to slide backward and forward on the rail, so that its position in the center of the tube can be regulated.

A thread of asbestos, dipping in the oil, passes up the wick-holder and projects just in front of the wick at the open end of the metal tube.

To use the lamp, the asbestos thread is first lighted. This furnishes a small flame at the mouth of the metal tube. If now the bellows be worked, combustion takes place within the metal tube on the surface of the gauze. The size of the flame depends on the position of the jet, since combustion is practically limited to that portion of the wick exposed to the air current. Thus, when the jet is pushed up to the open end, a fine-pointed flame is produced; as it is drawn back into the tube, the flame increases in size, giving a roaring flame when the whole length of the wick is exposed. On stopping the air supply the flame immediately subsides to its original size, and burns quietly at the mouth of the tube. In this way the flame is under complete control, and gives no trouble when not in use.

Experience has shown that the wick remains in good condition for a long time; in one case it was found to be only superficially blackened after the blowpipe had been in use for several weeks.

The dimensions given above are those which the author has found most useful for general purposes, but with a wick 2 inches wide, contained in a tube of 1-inch bore, a much larger and more powerful flame is obtained, suitable for large pieces of glass-blowing, although it is not so easily regulated for the production of a small flame.

The efficiency of the blowpipe has been proved by long use; with its aid all the ordinary glass-blowing which before was out of the question without gas may be done.—A. Richardson, Proc. Chem. Soc.

PENMAN'S WATER-TUBE BOILER.

We illustrate herewith a water-tube boiler designed by Mr. William Penman, of the well-known firm of boiler-makers in Glasgow, and constructed by them some months ago for running their works machinery. As one would naturally expect, in view of the fact that Messrs. Penman confine themselves to the making of boilers, leaving others to construct the machinery, the steam generator is essentially a boiler-maker's job. Indeed, one of its characteristics is its simplicity, while it contains more water than is usual with tubular boilers. All the tubes are drowned, so that circulation may be as rapid as the stoking requires. There is the usual steam collector or drum at the top, but instead of the tubes, which are inclined slightly to the horizontal, being screwed into junction boxes, or expanded into vertical tube-plates at front or back, forming headers, they are expanded into end chambers, of which there are two at both front and back of the boiler. These, as shown, are circular and of considerable length, built of a flanged tube-plate and a circular body, with an angle steel flange for securing the dished plate in front, which forms a manhole in smaller boilers or has a door in larger boilers. There is thus no trouble in removing a tube or of plugging it in the usual way, while the nest of tubes to which the injured pipe belongs may be stopped for the repairs.

This method of isolating part of the heating surface is one of the features of the design. It will be seen that there are two groups of tubes, with separate drums at front and back. The connection between the upper and the lower drums is through a series of curved tubes passing from the bottom of the upper to the top of the lower drums, and these tubes, which also are simply expanded, can be stopped by a lift valve fitting in a seat chamber within the upper drum and lowered or raised by a spindle extending through the top of the drum and fitted with a handwheel. In this way it might be possible to work one-half of the boiler while withdrawing a defective tube and expanding a substitute. There are also two outside circulating tubes, connecting with the upper drum above the water line, and these are fitted with a stop valve for shutting off connection. Under the drum at the back of the boiler there is a mud drum with the usual blow-out cock.

The general arrangement, it will be seen, is very

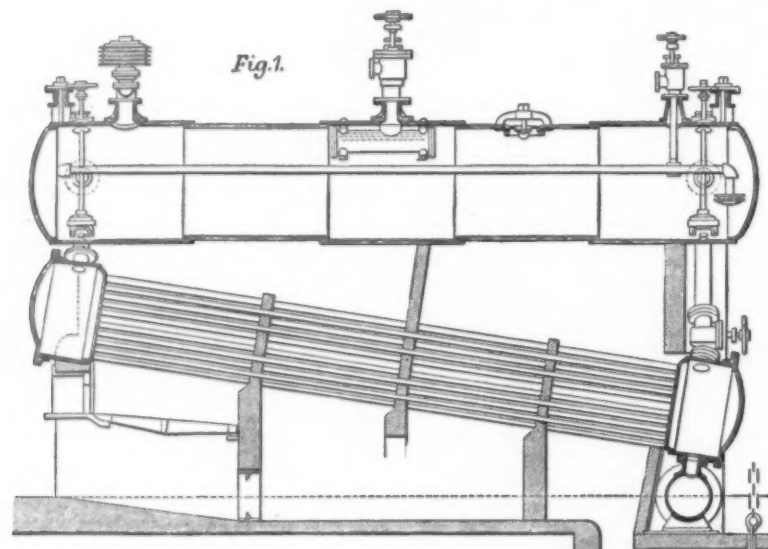


Fig. 1.

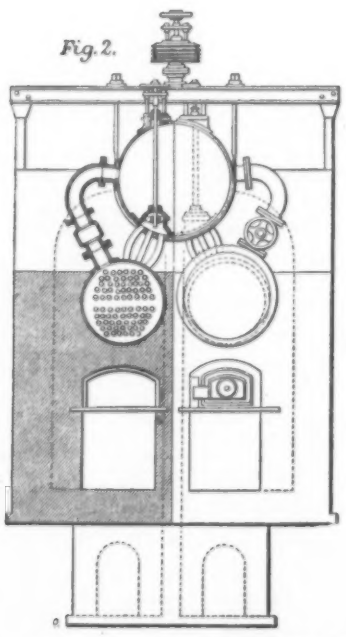


Fig. 2.

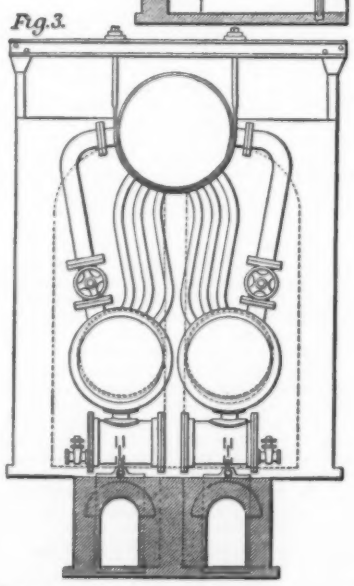


Fig. 3.

PENMAN'S WATER-TUBE BOILER.

simple, and although the boiler at the Caledonian Iron Works is not worked at a very high pressure, or to give forced results, it has done good work, according to the requirements, without indicating any weak element in design, and the many engineering visitors to Glasgow during the Exhibition period might, especially if interested in the problems of water-tube boilers, find an inspection of the boiler at work of much interest.—Engineering.

AIR LIFT PUMP.

We have recently, says The Engineer, through the courtesy of Mr. William Morris, had an opportunity of witnessing the working of an air lift pump by

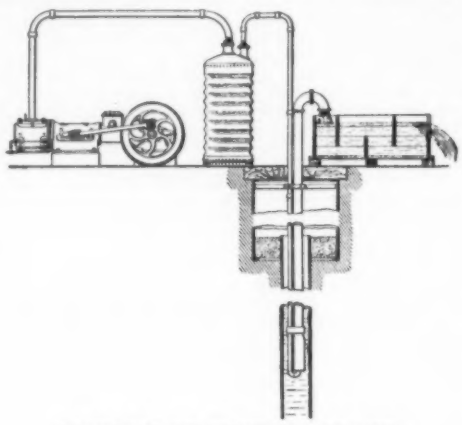


DIAGRAM OF PUMPING PLANT.

C. Isler & Company which was employed in testing a new bore-hole just completed by this firm for the Kent Water Company. A noteworthy circumstance in connection with this plant is the speed with which it was put to work. It was prepared, carried to the site, erected, and started in about a fortnight.

The bore-hole which was being tested was of the following dimensions: There was a well 25 feet in depth, lined throughout with a cast iron cylinder. This went down about 1 foot into the chalk, and from here to a depth of 82 feet there was a lining of 24-inch cast iron pipes with shrunk collars and counter shrunk bolts. The bore-hole was continued below this with a 23½-inch chisel to a total depth of 251 feet 3 inches. The 24-inch pipe stood up 2 feet into the bottom of the 6-foot well, and the bottom of the well was filled up to the level of the top of the 24-inch pipe with concrete. Although not fixed at the date of our visit, there was on the site and ready to be put in place on the top of this bed of concrete a disk of cast iron some 2 inches thick, with a central hole some 24 inches in diameter. The water rose to within about 5 feet of the surface when standing and sank to a depth of between 28 feet and 30 feet when pumping was going on.

The apparatus used in testing the output of this bore-hole consisted of a portable engine of 25 horse power nominal. A connection was taken off from the boiler of this to the air compressor, but as there was no injector it was necessary to occasionally run the engine of the portable so as to supply the boiler with water. This, of course, was only because the plant was of a temporary and make-shift character, and was highly inefficient, for the engine being large naturally absorbed far more energy than would be necessary to simply feed the boiler. The compressor used was of the horizontal two flywheel type with the steam and air cylinders arranged tandem. The steam pressure was kept at from 78 to 82 pounds on the square inch. The diameter of both air and steam cylinders was 14 inches, and the stroke 16 inches. The compressor was constructed to run at 100 to 120 revolutions a minute. It delivered air into a reservoir constructed of an old corrugated boiler furnace flue with ends riveted to it, and a connection from this was led to the bore-hole. Dipping down into the 24-inch bore-hole to a depth of 123 feet from the surface was a 7¼-inch rising main. Running down beside it was a 3-inch pipe coming from the air receiver. The bottom of the 7¼-inch pipe was widened out to 8½ inches internal diameter, and by means of two right-angled bends the 3-inch air pipe was turned up into this, projected upward some 2 feet 8 inches from the bottom of the rising main. This was the whole of the apparatus. The rising main delivered into a tank at a height of some 4 feet from the ground level, so that the total lift when we saw the plant at work was about 34 feet. At the end of the delivery tank, away from the inlet from the rising main, there was a rectangular notch exactly a foot wide. As observed by us at a point taken as far back from the weir as possible the height of water above the sill of the weir was 9¾ inches. According to Molesworth's tables, this is equal to 156.7 cubic feet per minute—say, 1,400,000 gallons per hour. The air pressure in the receiver started at 50 pounds, and decreased while pumping was going on to 39 pounds, at which it kept constant.

Mr. Gerald Morris, son of Mr. William Morris, the chief engineer of the Kent Water Company, has kindly put at our service the details of a rough test he made with this plant when working similarly to when we saw it. The quantity of water lifted was in this instance at the rate of 1,350,000 gallons a day for 24 hours. During a trial lasting 8 hours 20 minutes 14 hundredweight of coke was burnt. The actual efficiency arrived at from the compressor to the water pumped was 25½ per cent. The method adopted in arriving at these figures was to take the mean between the pressures of atmospheric air and the air as delivered to the receiver, and multiply it by the length of stroke, the area of the compressor, and the number of revolutions. The possible efficiency of a pump of this class is not high, but the particular value of the system, as well shown in the present instance, is its adaptability, and the absence of working parts in the well itself. Practically everything is above ground, and easy to get at should it go wrong.

USE OF BLAST FURNACE GAS IN EXPLOSION MOTORS.

The question of the direct use of the gas of blast furnaces has been the subject of very numerous publications, and the story of the first applications of it was told nearly three years ago. Since then so great progress has been made that it may be said that the difficulties inseparable from the beginning of every new industry are now overcome, and that we are entering upon an era of improvement of details of the best motors among many excellent ones.

Let us note, moreover, that if motors in which blast furnace gas is used seem to be assuming a genuine importance it is because the question of the purification of such gas has just been solved by a process that is as efficacious as it is simple.

In the presence of these results, recently acquired, we find an awakening of interest in all the industrial centers that are concerned with this important question; and, from this viewpoint, it will suffice to recall two remarkable lectures, one of them delivered by Herr F. W. Lürmann at Dusseldorf last March, and the other by M. Jules Deschamps at Paris last May. The first, by an eminent metallurgist, was especially interesting by the valuable documents and results of experiments put at the disposal of the lecturer by the works themselves; the other, by a distinguished engineer, embraced perhaps the most complete résumé of the history of the question and the most impartial description of the motors now in use.

We propose to summarize and discuss here the important work of Herr Lürmann, which was published in Stahl und Eisen of May 1, 1901.

Difficulties Capable of Retarding the Use of Blast Furnace Gas in Motors.—Herr Lürmann first recalls the fact that in a preceding lecture he pointed out the following difficulties as capable of retarding the utilization of blast furnace gas in explosion motors: (1) Variations in the composition of such gas; (2) the feeble power of the latter; (3) the large proportion of dust, and aqueous vapor that it contains. Up to the present practice has demonstrated (1) that the variations in the composition of the gas have no prejudicial influence upon the operation of the motors; (2) that its feeble calorific power in nowise constitutes a drawback. Instead of making, as with illuminating gas, a mixture of gas and air in the proportion of 1 to 7, it suffices to make a mixture of equal volumes when it is a question of blast furnace gas. Herr Lürmann might have added that the feeble calorific power of blast furnace gas permits of carrying the initial pressure farther, and that this has an advantageous influence upon the efficiency of the motor.

The question of dust is the one that has most occu-

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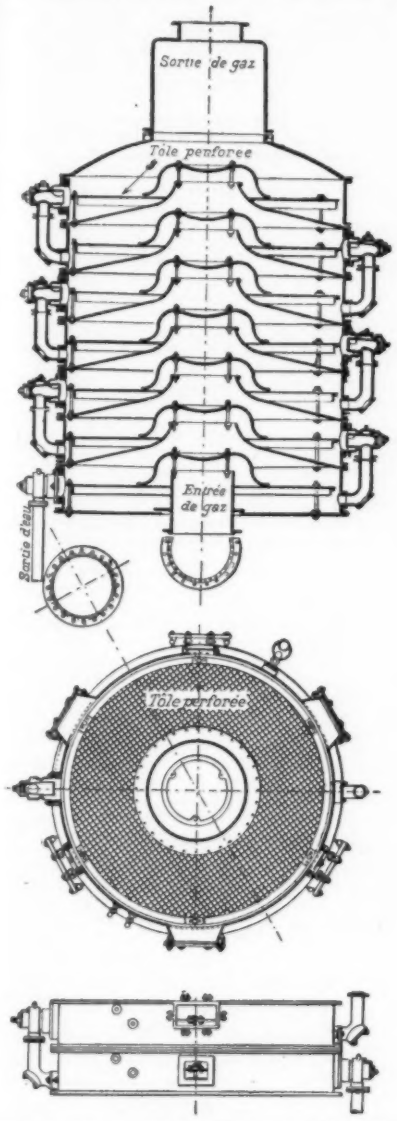
pied the attention of all those who have studied blast furnace gas motors. In Herr Lürmann's lecture of 1898 all that relates to dust occupies about four times more space than the rest, and the impression that the auditors received was that the engineer feared a check on this score, and the more so in that he terminated his lecture in prudently recommending metallurgists to await the result of the experiments of the Hoerde works, and in advising manufacturers of motors not to be in too much of a hurry.

As the fears expressed by Herr Lürmann at this epoch gave rise to a controversy between him and a



FIGS. 1, 2, AND 3.—KLOENNE GAS WASHER.

writer in Le Genie Civil, it will perhaps be well to recall in what terms the said writer finished his reflections upon the question of dust:

"It is certain," said he, "that we shall have to endeavor to carry the purification of the gas to as extreme a degree as possible without thinking, like Herr Lürmann, of purifiers analogous to those employed for illuminating gas, the installation of which would cost 800,000 francs for a furnace of a daily production of 200 tons."

In his last lecture Herr Lürmann pointed out the position that he had taken by saying that it was necessary to distinguish between the dense dust formed of coke, ore and stone slag, that it is very easy to arrest, and the light dust due to metallic and other vapors, which, through oxidation at the moment of explosion, give rise to very fine dust if they have not been eliminated before their entrance into the cylinders.

The aqueous vapor, which very disadvantageously

HORSE POWERS OF BLAST FURNACE GAS MOTORS CONSTRUCTED OR IN COURSE OF CONSTRUCTION ON MAY 15, 1901.

Manufacturers.	Germany	Luxembourg	France	Belgium	Austria	England	Spain	Russia	Italy	Total	Total per System
Cockerill at Seraing (Delamare Motor)	3,900	6,600	5,000	7,600		600		700		18,800	33,650
Participation Française (Delamare Motor)										5,000	
Société Alsacienne (Delamare Motor)	3,000						600			3,600	
Wetter sur Ruhr (Delamare Motor)	2,400								1,200	3,600	
Breitfeld, Daneck & Co. (Delamare Motor)	600	600			850				600	2,050	
Otto at Deutz	10,045	3,200	3,300					55		13,300	16,600
Compagnie Française des Moteurs Otto										3,300	
Oechelhauser	12,800				2,000			1,500		16,300	16,300
Nuremberg	6,740									6,740	6,740
Koerting, Hanover	5,105									5,105	5,105
Dubuisson, Eveno & Cie. (Letombe Motor)			900				1,740			2,730	2,730
Thwaite			250			2,000				2,270	2,250
Pierson (Crossley)			250							250	250
	44,590	9,800	9,700	7,600	2,850	2,600	2,340	2,255	1,800	83,625	83,625

at the head of the movement. In support of his statement he gives a table concerning the horse powers obtained with blast furnace gas motors now installed or ordered.

Herr Lürmann rightly observes that the English and especially the Americans, who usually imagine themselves to be at the head of all other nations from the viewpoint of new industrial applications, have, up to the present, done almost nothing in the domain of blast furnace gas motors.

The remainder of the lecture is divided into three parts:

A. Installations now in use for separating the dust and aqueous vapor.

B. Recent arrangements of gas motors.

C. Installations designed to economize and utilize blast furnace gas.

A. INSTALLATIONS NOW IN USE FOR SEPARATING THE DUST AND AQUEOUS VAPOR CONTAINED IN BLAST FURNACE GAS.—Great progress has been made in recent times in the purifying and cooling of blast furnace gas, especially with a view to the use of it in explosion motors. The dense dust has for a long time been separated by means of the dry or injection of water purifiers that are well known to all metallurgists.

But it is in but a few works that a complete purification is effected, that is to say, a perfect separation not only of the dense, but also of the fine dust, that may be carried along to hundreds of feet. Such a purification is possible only on condition that a cleansing be effected by wet way and the gas be cooled to the degree of the surrounding temperature.

VARIOUS APPARATUS FOR PURIFYING GAS.—Herr Lürmann describes a series of apparatus and installations, the accompanying figues of which are taken from Stahl und Eisen.

The first apparatus (Figs. 1, 2, and 3) is a washer with columns in which the gas ascends from the bottom to the top and traverses a series of perforated iron plates or wire cloths upon which water falls in a cascade so as to establish an intimate contact and a methodical circulation. An apparatus upon which greater hopes had been based is the Theisen centrifugal washer. According to an article published by the inventor in Stahl und Eisen, the following were the performances of an apparatus of this kind installed at the Hoerde works. The apparatus was 13 feet in length and 5 in diameter. Before its entrance into the centrifugal washer the gas contained 1.5 grain of dust and 16 grains of water per cubic foot, while the proportions were but 0.004 grain of dust and 13 grains of water at the exit. The apparatus was capable of washing 3,500 cubic feet of gas a minute, and consumed 1.08 cubic inch of water to the cubic foot of gas. The water, which entered at a pressure of from 1 to 1.5 inch of water, made its exit at a pressure of from 4.8 to 6 inches. Herr Lürmann saw this installation last September, before it was in regular service. Some French engineers who visited the works in November state that the apparatus appeared to effect a satisfactory purification, but that the following objections might be urged against it:

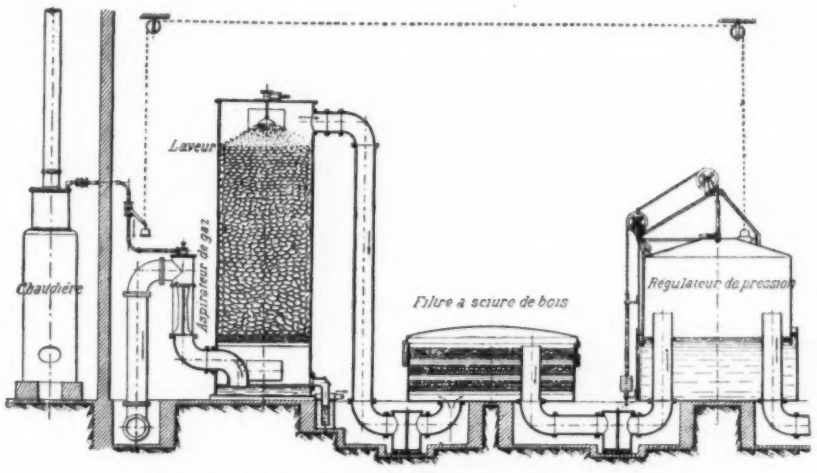


FIG. 6.—KOERTING GAS WASHER AND COOLER.

(1) The pillow blocks of the ordinary type give rise to heating.

(2) The joint between the stationary cylinder and the movable shaft is insufficient and permits of leakages of gas.

(3) The power necessary in the month of November was 45 horse power. Now, since 3,500 cubic feet of gas a minute can supply 1,700 horse power in gas motors, the power necessary for the purification would be 2.5 per cent of the power disposable.

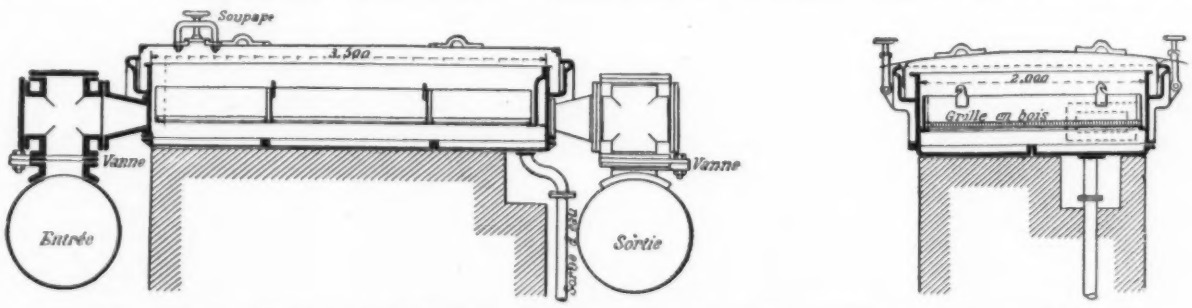
Herr Lürmann adds that the Theisen apparatus furnished to Differdange has never been able to operate in a regular manner. We learn that this apparatus has had to be put out of service, despite certain modifications introduced into it by another manufacturer.

At Hoerde it appears that this centrifugal purifier gives good results *when it operates*. The inventor claims that all that he has had to overcome have been the difficulties of construction.

In another order of ideas Herr Lürmann mentions a series of arrangements in which the principle is to cause the gas to traverse long pipes provided with numerous obstructions and receiving injections of water at different places.

As long ago as 1890 the Georgs Marienhütte Works, at Oberhausen, adopted purification by the wet way, and diminished the proportion of fine dust by from 3 to 1.04 grain per cubic foot. The purifiers of this works are 44.28 feet in height, 42.6 in length, and from 10 to 13 feet in width. Internal partitions divide them into two series of chambers, the first six of which have a horizontal section of 5 by 5 feet, the following one of 6.56 by 5 and the last of 8.2 by 6.56 feet. The gas rises and descends in these chambers and receives a shower of water from above. At a temperature of 160 deg. the gas contains at least 70 grains of aqueous vapor to the cubic foot. The temperature lowers to about 24 deg., and the proportion of water is reduced to about 11 grains to the cubic foot. The quantity of water necessary for the washing and cooling is about 3,500 cubic feet per hour for 35,000 cubic feet of gas. In order to permit of the deposit of the dust in suspension in the water there are 1,290,000 square feet of decanting basins having a depth of 5 feet. The cost of the first installation amounted to 37,500 francs.

The Gutehoffnungshütte, at Oberhausen, likewise has



FIGS. 4 AND 5.—SECTION OF SAWDUST FILTER EMPLOYED BY THE GUTEHOFFNUNGSHÜTTE.

affects the thermic product of the gas, is considerably diminished by the cooling that accompanies the purifying of the gas.

BLAST FURNACE GAS MOTORS NOW MOUNTED OR ORDERED.—Herr Lürmann next states that the applications have become very numerous during the last three years, and that Germany and particularly the Grand Duchy of Luxembourg have resolutely put themselves

for several years had at its disposal important installations for the separation of fine dust and aqueous vapor. These installations are based upon the use of special washers and sawdust filters, and are represented in Figs. 4 and 5. The quantity of washing water is reduced here to 17,500 cubic feet for 917,000 cubic feet of gas per hour; that is to say, it is proportionally five times less than in the preceding works. This gas is employed for the heating of the hot air apparatus, which consume 840,000 cubic feet, and for gas motors of a nominal 625 horse power. This gas contains from 2 to 3 grains of fine dust, and this proportion falls to 0.01 of a grain in the purifiers. The temperature of the gas before its entrance is 170 deg., and the amount of aqueous vapor that it contains is 7 per cent in volume. In the purifiers such temperature is reduced to 40 or 45 deg., and, at the entrance into the motors, becomes equal to that of the surrounding atmosphere.

The pressure of the gas falls from 6 to 3.6 inches of water as a consequence of the passage into the purifiers.

The installation cost 17,000 francs. At the rate of 35,000 cubic feet of gas an hour the cost would be 45,000 francs; that is to say, not much higher than in the preceding case, although the installation is much more efficient, since it reduces the quantity of dust in the proportion of 22 to 1, while the former reduced it in the proportion of only 2.5 to 1. It is certain that this much better result is due to the coke scrubbers and the sawdust filters.

The Donnersmarkhütte, of Silesia, possesses an installation for the purification of the gas of a 600 horse power motor consuming 63,000 cubic feet an hour. It appears that the proportion of dust is 6 grains to the cubic foot at the entrance into the purifiers and 0.024 at the exit. The temperature of the gas lowers from 38.6 deg. to 17 deg., and the quantity of water from 450 to 30 grains, the consumption of water being 756 cubic feet an hour. The cost was but 13,600 francs, but it must be remarked that the quantity of gas purified is very feeble. At the rate of 35,000 cubic meters an hour the cost would amount to 75,000 francs.

Fig. 6 represents an installation of purifiers such as proposed by the Koerting establishment of Hanover for the washing of the gas for a 100 horse power motor; that is to say, for 12,250 cubic feet an hour. The cost would be 4,500 francs, which is relatively high, but it is evident that the cost of an apparatus of this kind does not increase in proportion to the volume of the gas purified. This installation is based upon those in use for the gas of gas generators and comprises coke scrubbers and sawdust filters.

Witkowitz, in Moravia, uses a Schmalz apparatus that washes 9,450 cubic feet an hour and costs 5,000 francs—a very high price for an apparatus of so feeble a performance. It consists of two holders that descend alternately into a reservoir filled with water and that suck up the gas and afterward force it in very fine jets through the water. The amount of dust is thus reduced from 0.6 to 0.007 of a grain to the cubic foot. It remains to be seen whether the apparatus would be applicable to large installations. We do not think it would be.

Apparatus Based Essentially Upon the Use of Sawdust Filters.—The most complete and most improved purification installations exist at the Friedenshütte works in Silesia. The gas begins by traversing a series of three rectangular dry purifiers of 8.2 feet diameter and 72 feet in height, and enters another series of rectangular dry purifiers having a section of 6.56 and 9.84 feet and a height of 45.9 feet, and each subdivided into two chambers. The gas alternately rises and descends in the ten chambers thus formed, all of which have hydraulic joints. The total length of the travel of the gas is 722 feet.

From the main conduit, 60 inches in diameter, branches another conduit of the same diameter that is about 325 feet in length and leads the gas to the installations for the separation of the fine dust and aqueous vapor. This conduit is placed upon iron plate columns 32 inches in diameter that are provided with apertures at the lower part to permit of the occasional removal of the dust that deposits within.

The entrance and exit of the gas take place through flues having a section of from 16 to 20 inches and situated under the filters. Before its passage into these filters the gas still contains 0.024 of a grain of dust to the cubic foot. Each of these filters consists of a cast-iron box in which are placed two gratings of wood, and which is closed by an iron plate cover having a hydraulic joint. A piece of coarse packing cloth is first laid upon the grating, and upon this is placed a layer of sawdust 2.75 inches in thickness. The gas enters through a conduit which is 9 inches in diameter and is capable of being closed by a valve. After traversing two layers of sawdust from top to bottom it makes its exit from the lower part of the box through a conduit 9 inches in diameter provided with a valve. There is an aperture in the box for the outflow of the water and a valve for the escape of the air. The boxes are connected in fours with one conduit in common for the admission of the gas, and in eights with one conduit in common for the exit of the gas. A conduit 44 inches in diameter leads the gas to the gasometer, which is 26 feet in diameter and has a travel of 14.75 feet. There are two 6,600-pound traveling cranes for the maneuvering of the covers. The filters, sixteen in number, are placed in two halls 44.25 feet in width by 111.5 in length and affording space for forty filters in all. The cost of installation was relatively high, since the foundations, halls and cranes were arranged with a view to the use of forty filters. The cost may be divided up as follows:

Foundations	22,500 francs
Buildings	15,000 francs
Filters	22,500 francs
Gas conduits in the interior of the buildings	6,250 francs
Traveling cranes	5,000 francs
Total	71,250 francs

The following experiments were made in order to ascertain what volume of gas could be purified with a given surface of filter: The conduit leading the gas to the gasometer was closed, and, for eight minutes, the gas necessary for a 300 horse power motor was taken from the holder. The latter descended 7.8 feet, which represented a volume of 4,200 cubic feet, the diameter being 26 feet.

The barometric pressure was 29 inches. The gas pressure indicator marked a depression of 0.4 of an inch. The temperature of the gas at the entrance into the reservoir was 9.5 deg., and, at its exit, 8 deg. The filtering surface offered to the passage of the gas was varied by causing the latter to traverse a single box or several connected boxes. Such box had a filtering surface of 75.25 square feet.

According as all the gas was passed through the filtering surfaces offered by four, three, two or one box, the pressures at the entrance and exit were those indicated in the following table:

Gas circulating simultaneously	Pressures at the entrance to the boxes in inches of water				Pressures at the exit from the boxes in inches of water			
In 4 boxes	1.52,	1.40,	1.28,	1.60	1.08,	0.88,	0.80,	1.04
In 3 boxes	1.48,	1.52,	1.60,	1.52	1.08,	0.96,	0.80,	0.80
In 2 boxes	1.40,	1.52,	1.60,	1.60	0.64,	0.80,	0.64,	0.68
In 1 box	1.40,	1.68,	1.60,	1.60	−0.40,	+0.12,	+0.12,	0

It results from this table that the filtering surface of two boxes (150.5 square feet) is adequate without the loss of charge becoming too great, while the surface offered by a single box gives rise to too great a depression. The consumption of gas, analogous to that of the first experiment, was 4,550 cubic feet in 8 minutes; that is to say, from 560 to 595 cubic feet a minute. The temperature of the gas at the entrance to the filters was 13 deg., and 9 deg. at the exit therefrom.

It may, therefore, be said that it requires about 10.75 square feet of filtering surface to give passage to 35 cubic feet of gas a minute. In order to be able to purify 21,000 cubic feet a minute, that is to say, the quantity necessary to supply 1,000 effective horse power, it would require about 90 filters in service and 10 in reserve. In this case the cost of installation would reach 250,000 francs, and the building would occupy an area of 25,800 square feet. If, instead of juxtaposing all the boxes, they were superposed in sixes, the cost might be reduced to about 175,000 francs, and the surface occupied by the building to 6,450 square feet. The purification is effected without consumption of water, and the net cost would be established in the following way:

In order to cause the passage of 35 cubic feet of gas a minute it requires 35 cubic feet of sawdust a month. Admitting the cost of 2 francs per 35 cubic feet of sawdust and 21,000 cubic feet of gas a minute, the monthly expenses for sawdust would be 1,200 francs. For the service of 100 boxes it would require two men a day at 3.75 francs, say, 225 francs a month. Let us add 100 francs a month for the changing of the cloths, wear of the apparatus, lighting, etc., and we shall have a total expense of about 1,500 francs a month.

The quantity of dust at the exit from the filter is reduced to 0.008 of a grain, and the quantity of water to 2.4 grains to the cubic foot. These are excellent results, but the installation is costly. Let us admit, in fact, that it were necessary in this way to purify the gas derived from four furnaces of 150 tons daily production, corresponding to 70,000 cubic feet of gas a minute. It would then require 300 sawdust boxes occupying a space of 86,000 square feet, and the cost of the first establishment would be 850,000 francs.

Fortunately installations so costly are not necessary, since the use of openings for injecting water permits the reduction of expenses to a considerable degree. —For the above particulars and the engravings we are indebted to Le Genie Civil.

Bids for Rolling Stock for Belgian Roads.—Consul-General Guenther reports from Frankfort, July 9, 1901:

According to the Revue Industrielle, the management of the Belgian government railroads contemplates a considerable increase of rolling stock in the near f ture. In addition to 570 cars already advertised for in the official gazette, the furnishing of several hundred passenger cars and 100 locomotives will be awarded under the bid system.

SOME MOTIONS, RELATIVE AND ABSOLUTE.

By OBERLIN SMITH.

To a majority of people a state of motion implies some object apparently moving, and a state of rest something apparently standing still. To a smaller class of observers, who really give more or less scientific thought to the matter, all motion seems but relative, and the remark might be made that every motion in the universe, so far as we know it, is simply relative; that an object upon this earth which seems to us absolutely at rest is really moving eastward by the diurnal revolution of the earth at the rate of about 1,000 miles per hour; while an object apparently moving westward at the same speed, for instance, a cannon ball (which in some cases actually does move at about this velocity), is really in a state of rest; that is, when considering the earth's axial motion only.

If our thinker goes further, however, and considers the motion of the earth in its orbit, he realizes that these respective motions, or states of rest, may be much modified—the motions being partly or entirely neutralized, as in the above mundane supposition, or perhaps even reversed. Looking still further, and considering the motion of the solar system among the other systems of the universe, and possibly of this universe, so called, among other universes, he can but conceive the actual motions involved as inextricably confused, and he must resolve them into puzzlingly unknown quantities.

If he be a rather broad-minded thinker he will realize that perhaps a state of absolute rest is inconceivable, and that there is really after all no difference between rest and motion in an object, except considered relatively to other objects. Whether or not this be true, however, is one of those questions which the human mind, in its present state of development, can no more decide than can it understand the great problem of the infinity of time and space, and the seemingly impossible existence of either these or of any alternative conditions.

The practical-minded thinker, working perhaps in engineering lines, will avoid transcendentalism and see at first sight that he has but to deal with relative motions. Considering some such diagram as Fig. 1, he will conclude that it makes no possible difference, regarding the surface of our earth as stationary, and considering their final positions in relation to each other, whether an object, *A*, remains at rest while *B* moves to the right, in the direction of the arrow, following the straight dotted line; or, whether, as a second condition, *A'* moves to the left, in the direction of the arrow, while *B'* remains at rest; or, further, as a third condition, whether *A"* moves to the left, while *B"* moves to the right, as shown by their respective arrows.

Fig. 1.

Fig. 2.

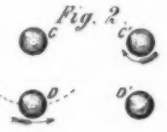


Fig. 3.

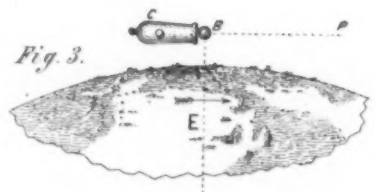


Fig. 5.

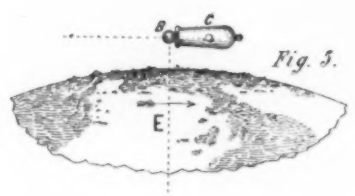


Fig. 4.

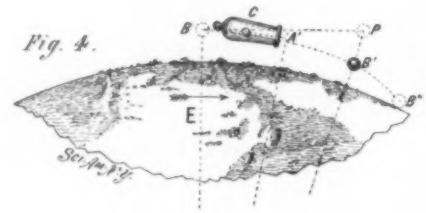
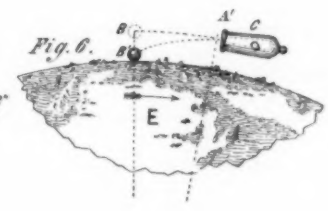


Fig. 6.



Considering conditions shown in Fig. 2, he may go farther and say that in mechanics it makes no difference whether the object, *C*, is stationary with the object, *D*, revolving in a circular orbit around it, as shown by the arrow, or whether, as in *C'*, the object revolves in the opposite direction upon its own axis, while the other one at *D'* remains stationary. If it is true, geometrically and kinetically considered, his conclusion will be correct, for it is obvious that the relative motions of the respective objects in Fig. 1 are identical, as they also are in Fig. 2. Considered in a practical light, in the domain of mechanical engineering, the proposition would sometimes be true, part[illegible] in cases where the motion was so slow that the [illegible] of inertia, in the form of centrifugal force and otherwise, would not be appreciable to any harmful extent.

There are, however, serious limiting conditions in practical work. One of these applies to all reciprocating motions, whether in straight or curved lines, and in general to any motions where the velocity rapidly changes in degree, or in direction, or both. An instance of this is shown in planing and shaping machines; in printing presses, in the carriages of sawmills, etc. In such cases a heavy object, as the platen or carriage of the machine, moves in a straight line, and is not affected by centrifugal force, but its sudden losses and gains of velocity and change of direction for the return motion put definite limits upon speed and weight. It, therefore, often becomes an important point with the designer and engineer, in the case of relative motion between two masses of matter, to decide which mass shall not change its velocity, but shall remain at rest in relation to the earth. Thus

with heavy planing machines it sometimes becomes necessary to move the tool-carrying devices, rather than the work itself, which latter is often very heavy, and is mounted upon a still heavier reciprocating table.

In the case of rotary motions in machines, a new trouble arises, even though the velocity may be uniform or nearly so. This is due to centrifugal force, and gives rise to two practical difficulties. One of them is the bursting tendency involved, which in all mechanics gives a fixed limit of speed, dependent upon the tensile strength of the materials involved, together with an allowance of a considerable safety factor. A practical instance of the changing of a machine, in regard to the respective motion or rest of two objects having a relative rotary motion, may be seen in some large dynamos, where a decided advantage is secured by causing the field to revolve around the armature rather than the armature within the field, as is most usually the case. With this construction certain delicate parts, as wire-wound field-magnets, etc., are held by centrifugal force outward against a retaining ring, which it is easy to make of ample strength. In the more common construction, on the contrary, analogous delicate parts of the armature have a tendency to fly away from the central spider upon which they are mounted, causing greater practical difficulties in the way of holding them in place. It is obvious that the relative motion of the two important members of the machine in question is exactly the same in either case, but that, owing to inertia manifesting itself in what we call centrifugal force, serious differences of action may arise, according to which of the bodies remains at rest.

Another important phenomenon in connection with one object revolving around another one arises in such cases as the placing of irregular work in lathes, boring-mills, etc. Should such work not be accurately balanced about the axis of the revolving spindle to which it is attached, when any considerable rate of speed is attained, a violent vibration is apt to be set up in the framework of the machine, as in the case with any unbalanced object revolving about a fixed axis, while attempting to make a new axis for itself nearer its center of gravity. The same difficulty is met with in various other machines; as, for instance, certain spinning devices, where it makes a decided difference whether an outlying spool revolves about the central stationary one, or whether the central one itself revolves.

In some of the machines mentioned both the difficulties arising from ill-balancing and from a tendency to burst have to be contended with. Should the machine in question not have a uniform rotary motion, but a reciprocating oscillation, or a rotation in which the speed greatly varies at different points in its cycle of revolution, then all three of the evils above mentioned might perhaps be present. It will, therefore, be seen that the general principle of the relative positions of two or more objects at different times being the same, no matter which or how much any of the objects move, will apply theoretically (outside the domains of mere geometry and kinetics) only to cases where the motions are in *straight lines*, and are *uniform in velocity*. Practically considered, these conditions may be departed from if the motions are slow enough, or their rates of velocity-change small enough, or the curvatures of the lines in which they move of large enough radius to meet the mechanical conditions involved, in regard to mass and shape.

Were these things not so, then the astronomical doctrines of the ancients and, later, of Br'er Jasper, of Virginia, might be true, and the respective members of the solar system might gayly career at will about their great and important stationary Earth. Furthermore, the sun might actually have taken a vacation for a little while—in the way he seemed to do in the eyes of Joshua.

In thinking over the subject in question some years ago, it occurred to the writer that an interesting proposition arising from the principles mentioned would be that: *A cannon ball fired from a given elevation under given conditions will take longer to reach the earth, and, therefore, will go farther if fired toward the east than toward the west.* At a glance this would seem unlikely to the casual thinker, who considers that any motion of the kind is simply relative to the earth, and that such a cannon ball would behave in the same manner if fired in any direction. It may be that this proposition is an old one, but the writer has not happened to hear it stated, nor does he know of its ever having been published. Several scientific friends, working in the domains of mathematics and physics, to whom he has mentioned it, at once admitted its truth, but did not remember before having heard of it.

In considering the conditions shown in the diagrams, the motion of the earth in its orbit, as well as the motion of the solar system through space, will be disregarded as unimportant. This is especially the case with regard to the orbital motion, if we assume the time to be at about sunset or sunrise, and the place near the equator. It will be further assumed that the surface of the earth is traveling at about 1,500 feet per second (which is nearly correct at the equator) and that the speed of the cannon ball in question is at the same rate. This velocity would be correct for a good conservative-minded cannon of even more stumpy" appearance than those pictured, although not up to the best modern practice.

Referring to Fig. 3, in which *E* is a portion of the earth revolving eastward, as shown by arrow, *C* is a cannon with its axis perpendicular to the earth's radius, *E*, and at a height from a smooth globular earth's surface of about 16 feet, plus half the diameter of the ball, *B*, which in this diagram has just left the mouth of the gun, moving in a tangential eastward direction, *B P*. To be strictly correct the ball should be shown with its center at the gun's mouth—but this does not matter.

In Fig. 4 is shown the condition of things one second later, when the cannon has moved 1,500 feet eastward, with its mouth in the arc, *B A'*. Meanwhile, the ball has started to move from *B*, its original position in space, in a straight line to the point, *P*, 3,000 feet distant (disregarding air resistance), the distance moved being due to its initial velocity, given it by the earth's motion, plus its velocity as a projectile, given by the action of the gunpowder. During the second in question, however, it has fallen approximately toward the center of the earth about 16 feet, to the point, *B'*, which being above the earth's surface leaves it free to continue in its space trajectory, *B B''*, until it strikes the earth at *B''*—obviously a greater distance than the 3,000 feet in question.

Taking all conditions the same except that the cannon is pointed westward, as shown in Fig. 5, we have, at the instant of discharging the ball, *B*, from the mouth of the gun, a position apparently similar to that in Fig. 3. In this case, however, the motion of the ball as a projectile is absolutely neutralized by the earth's motion, and the gun has simply fired itself away from the ball, leaving the latter suspended motionless in space at *B*.

In Fig. 6 we have the conditions one second later, when the cannon's mouth has moved in an arc 1,500 feet eastward to *A'*, and when the ball has simply fallen toward the center of the earth about 16 feet, until it has touched the surface. Its trajectory relatively to the earth has, in this case, evidently been from *A'* to *B'*, while its space trajectory is the vertical line, *B B'*.

In addition to the reason above given why a ball should shoot farther eastward than westward, there is another one which, at the height assumed, would be almost inappreciable, but which causes weights dropped from considerable heights to fall perceptibly eastward of the point which a plumb line would designate as directly beneath the starting place. This phenomenon, as has been practically proved, is due to the weight moving faster when at a distance above the earth, by reason of its traveling in the same time through a larger arc of revolution. Maintaining this rotary speed as it drops, it, of course moves farther in a given time than does the surface of the earth, which causes it to gain upon the latter and beat it in the race.

This action would have no effect upon the ball fired westward if we assume the eastward velocity of the cannon's mouth, at the elevation given, to be equal to the shooting velocity—leaving the ball, as in the original assumption, stationary in space. In the case of the eastward shooting, however, the action referred to would slightly increase the effects under consideration.

The exact position of the ball when at *B'* it is not necessary here to determine, and an analysis of its motion in relation to time suggests studies of a mathematical character with perhaps the application of Kepler's second law. In considering this proposition, based upon the conventional speeds in vogue with proper-minded earths and cannon balls, the action explained is evident by an inspection of the diagrams, although the latter are, of course, enormously distorted in regard to the smallness of the earth's arc, the bigness of the cannon, etc. The phenomena in question, however, would not be the same at all velocities, as there is, of course, a critical point beyond which the ball would move so fast that it would fly entirely away from the earth and become truly a satellite, if not a comet. It would seem a general proof of the proposition, however, that slightly below this critical velocity the ball would, in its tendency to act like a satellite, go a long distance around the earth before striking it, this distance lessening gradually with a decreasing velocity.

It may be remarked that the above proposition is not recommended to the notice of artillerists as a practical guide, specifying from what point of the compass to shoot when attacking the enemy. The actual effects in regard to an increase of eastward trajectory would, of course, be too small for consideration in practice, and would be dependent in amount upon muzzle-velocity, elevation, etc. It is evident that this proposition may be explained diagrammatically as above; or, it may be referred to in general as belonging to the phenomena arising from centrifugal force acting upon cannon balls and other planets in space—such force obviously being greater at 3,000 feet per second than with no motion at all, as in the second case of the proposition. As so often happens, however, the principles involved, as well as those enunciated in the earlier paragraphs of this article, may perchance lead to ideas which will be useful in practical engineering.

CONTEMPORARY ELECTRICAL SCIENCE.*

VELOCITY OF BECQUEREL RAYS.—W. Kaufmann attempts to arrive at an accurate estimation of the ratio e/m for Becquerel rays. This estimation is of great interest, as we have probably to deal in this case with velocities approaching the velocity of light, and the behavior of electrons with such velocities is of special theoretical importance. The determination of both v and e/m requires at least two observations, such as the magnetic and the electric deflection. The heterogeneous character of the radiation here presents a difficulty, since the rays are drawn out in a continuous spectrum, and it is almost impossible to identify the beams subjected to definite magnetic and electric deflections. Another difficulty lies in the conductivity of the air produced by the rays, which reduces the deflecting electric rays. The author avoids the latter difficulty by placing the whole apparatus in a vacuum, and the former by employing a method corresponding to Kundt's crossed spectra as used for the study of anomalous dispersion. The magnetic and electric fields were parallel, and the curve produced on a sensitive plate, mounted at right angles to the fields, was anything between a parabola and a straight line. The curves obtained so far approximate rather to the straight line, which would argue very high velocities; but before giving results the author intends to employ much stronger electric fields.—W. Kaufmann, Physikal. Zeitschr., July 13, 1901.

DIELECTRIC COHESION.—A gaseous mass placed in a uniform electric field allows the passage of an electric discharge as soon as the E. M. F. surpasses a critical value, below which the gas is a perfect insulator. E. Boutz tests whether the wall of the vessel in which the gas is contained has any effect upon the critical E. M. F., and answers the question in the negative. If the vessel containing the gas were strictly spherical and of uniform thickness, and if it were made of a perfect dielectric, the internal field would be uniform but slightly less intense than the external field. For instance, with a radius of 3cm., a thickness of 2mm. and a dielectric constant of 2.25, the interior field would be about 3 per cent below the exterior field. The author carried out two measurements of the field, one with a glass bulb coated internally with a very thin film of paraffin, and another when enough paraffin was introduced to double the thickness of the wall. The result was a reduction of the interior field by 3 per cent. But no coating of the inner wall has any influence upon the critical E. M. F. Irregularities of shape give rise to local discharges which precede the general discharge, and are due to a lack of uniformity of the internal field.—E. Boutz, Comptes Rendus, July 22, 1901.

URANIUM RADIATION AT VERY LOW TEMPERATURES.—H. Becquerel has studied the radio-activity of uranium compounds at the temperature of liquid air. He shows that at that temperature the radiation is substantially the same as at ordinary temperatures. This supplements the fact that no variation is shown between the temperatures of —20 deg. and +100 deg. Uranium nitrate, when plunged into the liquid air, or, better still, into liquid hydrogen, becomes luminous, and so does the platinocyanide. This is an electric phenomenon due to molecular contraction. The luminosity only lasts while the crystal is cooling down, but it can be renewed by allowing it to regain the ordinary temperature, as the luminosity is seen both in heating and cooling. The phenomenon is, however, intermittent, and does not show the steadiness of thermo-luminescence. While the crystal is immersed in liquid air, it emits a luminescence as it impinges on the glass walls of the vessel similar to that of mercury when shaken up in a vacuum. Crystals of the double sulphate of uranium and potassium do not show any of these phenomena. The luminosity is, therefore, probably due to electric effects connected with compressions and cleavages in the nitrate, which becomes an insulator at the temperature of liquid air.—H. Becquerel, Comptes Rendus, July 22, 1901.

PHOTO-ELECTRIC EFFECTS.—The facility of discharge by the action of light, and more particularly ultra-violet light, has, since its discovery by Elster and Geitel, become of great theoretical importance. The absorption of light waves gives rise to intra-molecular forces which tend to separate a small negatively charged corpuscle from the rest of the neutral molecule. The maximum impulse so given to the negative particle may give it a velocity away from the surface sufficient to carry it beyond the range of molecular action, while the same outward impulse acting upon the much larger positive mass is not sufficient to take it beyond the influence of the attracting forces. Hence the impact of light only influences a negative discharge, while a positively-charged body remains practically unaffected. J. Zeleny has studied the effect of temperature upon the discharge from a platinum wire. He found that from a platinum wire the negative electricity is at first discharged more slowly as the temperature is increased; the rate of discharge reaches a minimum and then increases as far as the highest temperature employed (700 deg.). The rate of the discharge produced by the light also depends upon the immediate previous history of the wire. On coming to certain temperatures from a higher one, the rate of discharge is much greater than if a lower temperature had been used just before. For small ranges at least this effect appears to be independent of the electric intensity and of the intensity of the light. After the reduction of temperature the rate of discharge gradually becomes smaller with time, showing that the large conductivity at first is due partly at least to the fact that the wire reaches its steady state but slowly. The recovery is much faster at temperatures below a certain point than for those above, the change being fairly abrupt. From an iron wire the rate of discharge also appears to diminish at first with the temperature, but after reaching a minimum it finally becomes a great many times its value at room temperature. Heating the wire does not change the inactivity of the light for discharging positive electricity, even though the wire is raised to a temperature where, due to the heat alone, the positive electricity is being discharged.—J. Zeleny, Phys. Review, June, 1901.

THERMO-MAGNETIC EFFECTS IN TELLURIUM.—If a conducting plate carrying an electric current be placed in a magnetic field perpendicular to the lines of force, various galvano-magnetic effects may be observed: 1. A difference of electric potential is produced between the edges of the plate, perpendicular to the current and the field (Hall effect). 2. A difference of temperature is produced between the same points (Ettinghausen effect). 3. A change of resistance occurs (longitudinal Hall effect). 4. A difference of temperature is produced in the direction of the current. If the current is replaced by a flow of heat, four analogous thermo-magnetic effects are observed: 1. A difference of electric potential between the edges of the plate (Nernst effect). 2. A rotation of the isothermal lines or a difference of temperature between the same points (Leduc effect). 3. A change of conductivity for heat (Righi effect). 4. A difference of potential in the direction of the heat flow (longitudinal Nernst effect). All these effects have been observed in bismuth, and some of them only in bismuth. M. G. Lloyd has found all the transverse effects to exist in tellurium, and has determined their constants. They are 0.0002 for the Ettinghausen effect, 0.36 for the Nernst effect, 430 for the Hall effect, and 0.000004 for the Leduc effect. In tellurium, the transfer of electricity is always in the same direction as the transfer of heat; that is, the edge which is raised in potential is also raised in temperature. In bismuth, the reverse is the case, the heat and electricity being transferred in opposite directions. Thus, the edge which is warmed by the Leduc effect has its potential lowered by the simultaneous Nernst effect.—M. G. Lloyd, Am. Jour. Science, July, 1901.

ALUMINIUM CELL RECTIFIERS.—C. Pollak has told us that it is not practicable to put aluminium cells in series when used as rectifiers of alternate currents, on account of unavoidable inequalities of the aluminium plates, which require different quantities of electricity

*Compiled by E. E. Fournier d'Albe in The Electrician.

for their preparation, and lose differently when in open circuit. This objection can be removed by connecting suitable resistances in parallel with the voltameters which lose least, so as to equalize the quantities of electricity required for each element.—C. Pollak, Comptes Rendus, July 8, 1901.

New Solution for the Copper Voltameter.—The importance of the convenient and accurate method of measuring electric currents by the voltameter depends very largely upon the construction of a voltameter which admits of high current-densities. As ordinarily used, the copper voltameter is subject to irregularities due to the solvent effect of the solution in some cases and the oxidation of the copper in others. W. K. Shepard has found a voltameter solution which avoids these irregularities. It is prepared as follows: A saturated solution of copper sulphate is boiled for a short time to expel the air, and then kept at 100 deg. C. for about an hour in contact with metallic copper in order to neutralize the solution. The density is then about 1.20. A very small amount of NH_4Cl is added, about 0.05 per cent. The weight of copper deposited is practically independent of the temperature between 20 deg. and 40 deg. The results are independent of the current density up to 0.07 ampere per square centimeter. The solution may be used a large number of times, with a current density two or three times as great as that permissible with others commonly in use, thus allowing the use of a smaller voltameter. Instruments may be calibrated to within 0.1 per cent.—W. K. Shepard, Am. Jour. Science, July, 1901.

THE SPRAGUE TRAINS.

An important question that presents itself when it concerns the make-up of a train of a certain total weight that has to run at a definite speed is the adhesion. The weight supported by the driving wheels must be in a given ratio to the tractive force that the engine has to exert, without which they will no longer adhere to the rails, but will revolve without advancing.

For the services of great lines there are constructed very powerful and very heavy locomotives capable of hauling the most heavily loaded trains at a high speed. The rapidity of starting is of but little importance, being given the relatively small number of stations. Moreover, with the use of steam as a source of motive power, it is impossible to think of adopting any other system than that of the present locomotives, which are very nearly perfect. The question of adhesion assumes a very particular importance upon lines upon which the stations are not far apart, since it is this that governs the starting, that is to say, the time that it takes the train to get under full speed. The problem may be taken up with profit when it is a question of electric traction, and, in this case, for city or suburban lines, we may try to ascertain what, from the viewpoint of adhesion, is the best means to employ. Up to the present, a motor car situated in front has been almost exclusively employed. This is provided with one, two or four motors mounted upon the axles of the wheels.

The motor carriage alone has to possess the adhesive weight required by the train as a whole, and it therefore follows that if such weight is inadequate and does not permit of the heavy stresses of a rapid start, the locomotive must be overloaded with a very great dead weight.

If, on the contrary, we suppose that all the cars are motor ones, and we provide all the axles with independent motors, the train will be converted into a sort of immense tractive apparatus, the entire weight of which, without supercharge, may be utilized for traction. As the adhesive weight is considerable, it will be possible greatly to increase the tractive force without any danger of the wheels sliding. Thus, for effecting the starting, it will be possible to utilize a considerable degree of energy for a very short time instead of employing a relatively feeble and continuous force. The train will then be able to get under way at a rapid speed almost immediately. Then, if the distance to be covered is not very great, it will be possible to arrest the output of energy and let the train run on in progressively diminishing speeds so as not to have to put on the brakes until just before stopping.

The superiority of trains with multiple motors is undeniable, putting aside the question of the expense of the first establishment, which, however, is but little higher than it is with trains with single motors. There is, therefore, a calculation to be made for each particular method.

The superiority of multiple motors being admitted, it became necessary to see how the principle could be put into practice. One of the great drawbacks to the use of such motors consisted in the difficulty of controlling them. It was necessary to have recourse to one motorman per car; a perfect harmony had to prevail among the movements of these different agents; and in order to make it possible for all of them to act at the same time, electric or phonetic signals were necessary; briefly, the solution of the problem, very pretty in itself, seemed to present serious difficulties in practice.

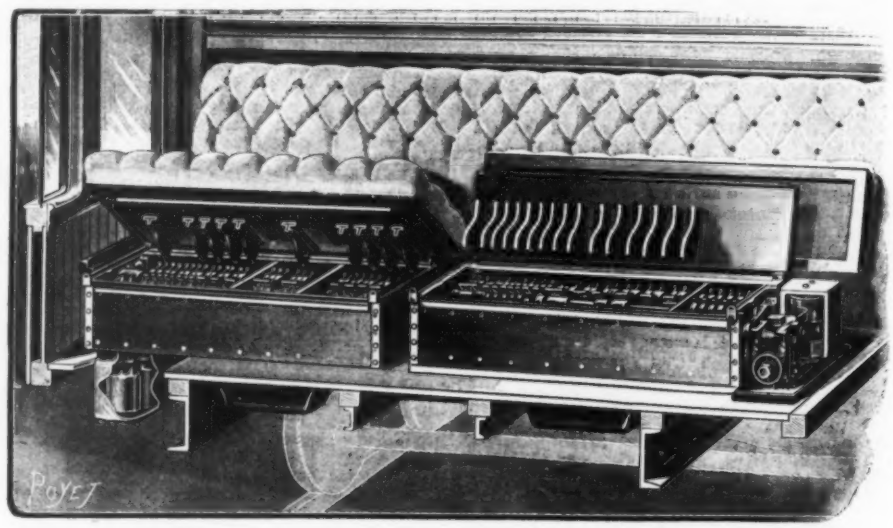


Fig. 2.—ARRANGEMENT OF THE CONTROLLER AND CURRENT REVERSER UNDER THE SEATS.

Mr. Sprague's invention consists in rendering all the motions automatic, under the control of one man located in the front car. This man has at his disposal a small apparatus called a manipulator, the object of which is to actuate the controller and reverser of motion that are situated in the vicinity of each motor, that is to say, under the seats of the different cars of the train (Fig. 2). This apparatus receives the current directly from the line (by lateral rail, trolley or otherwise). The idea that Mr. Sprague has put into practice is that of connecting the different cars, or of connecting the controlling and reversing apparatus of each car, by controlling circuits traversed by currents of very feeble intensity. The magnets operate automatically under the action of the motorman, who has the manipulator at his disposal.

We shall not enter here into a description of the different apparatus, the construction of which is quite complicated, but shall merely explain how they are employed. The object of the reverser is to change the direction of revolution of the motor in order to permit of the running of the train in both directions. To effect this contacts placed upon a movable cylinder are situated in such a way as to allow of a change of direction of the current. This cylinder revolves by a certain angle in one direction or the other under the action of a chain, the two parts of which are held by soft iron rings situated at the center of two independent coils. When the controlling current is sent into one or the other, the piece of iron will be attracted either on one side or the other and will actuate the cylinder through the intermedium of the chain. It will be seen that in the middle position there will be an absence of contact, and consequently an absence of current, which will cause the stoppage of the train. In this central position, a spring causes the cylinder to return when the entire controlling current ceases; for example, in the case of a breakage of the coupling.

The rôle of the controller is more complex. In practice, as is well known, it is necessary to have it in one's power to vary the velocity of the motors. Such velocity depends upon the difference of potential at the terminals of the motor. On another hand, it is impossible to send the current immediately into the motors not yet in motion, with all its intensity. A beginning is therefore made by diminishing the current, in a manner, by causing it to pass through resistances, of which the number is progressively reduced until they are absolutely eliminated from the circuit when the motor is running at its normal velocity. The object of the controller is to introduce various combinations of circuits corresponding to the resistances. Like the reverser, it consists of a cylinder capable of revolving under the action of a small auxiliary electric motor set in operation by the controlling currents (Fig. 2).

The starting resistances must not be diminished too quickly, since the motors might be seriously injured by too great changes of intensity. So the controlling current that sets in motion the motor that actuates the controller passes through a regulating apparatus which interrupts it every time the intensity of current of the motors exceeds a limit fixed in advance. In this way, every motor car becomes its own regulator, and the work of each motor is adapted to the special conditions in which it is placed. It is this that permits of uniting in the same train motor cars differently charged and having wheels more or less worn, etc. If the motors had not their own regulator, it would happen that certain of them would receive too little current and others too much. As we have above stated, the reverser and controller are, as a general thing, actuated by the motorman. In the Sprague trains, the apparatus is located under the seats of the different cars, and though at a distance from the motorman can be operated by him by means of electric devices which enable him to put all of them in motion at the same time and in the same manner.

The Sprague trains possess still another advantage, and that is that they can be divided up at will, so that the number of motors carried always corresponds to the weight to be hauled. This in many cases effects a considerable saving.—La Nature.

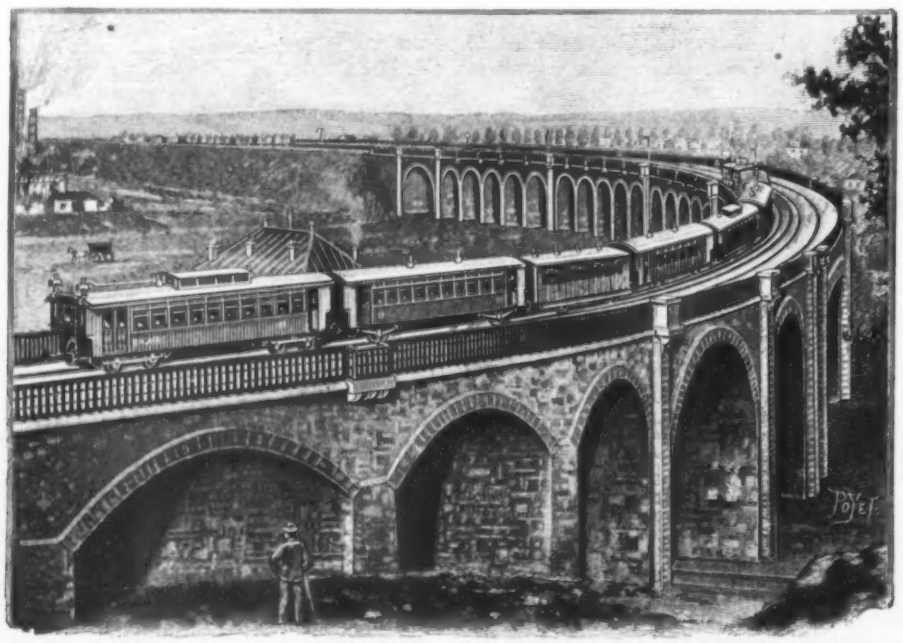


Fig. 1.—A SPRAGUE TRAIN PASSING OVER THE VIADUCT OF THE PLAIN OF ISSY.

NEW METHOD OF PHOTO-PRINTING.

For the printing of positives, amateurs in photography are tending more and more to employ artistic processes based upon the use of Artigue, Farineau and Fresson papers, bichromated gums and other preparations. But professionals, who have to furnish quite a large number of prints from the same negative within a limited period of time, necessarily have to adhere to processes that permit of a more rapid printing, and in which bromide paper renders them great services. As is well known, with such paper a print by artificial light can be obtained, but the image has to be developed. Hence there is often a cause of irregularity in the images produced, the tone and the effect obtained varying with the time of exposure. The latter must be the same for all the prints if it is desired to have them identical. Moreover, as it is the same negative that is used for the entire series, there is quite a notable loss of time in the charging and discharging of the frames for each operation. It is for simplifying this mode of printing that MM. Rancoule and Lantuejoule have devised the "Minerva photo-printer," so named by analogy with the small presses used in printing offices for doing work of slight importance.

With this apparatus it is possible in 6 minutes to obtain 13 prints of carte de visite size, and 6 of album size in 3 minutes.

The apparatus consists of a table, in the center of which there is an aperture, *H*, designed for the reception of the negative. The dimensions of this are varied by the insertion of wooden frames (called "intermediates") of the size of the negative used.

LIBRARY EDISON ELECTRIC 21543

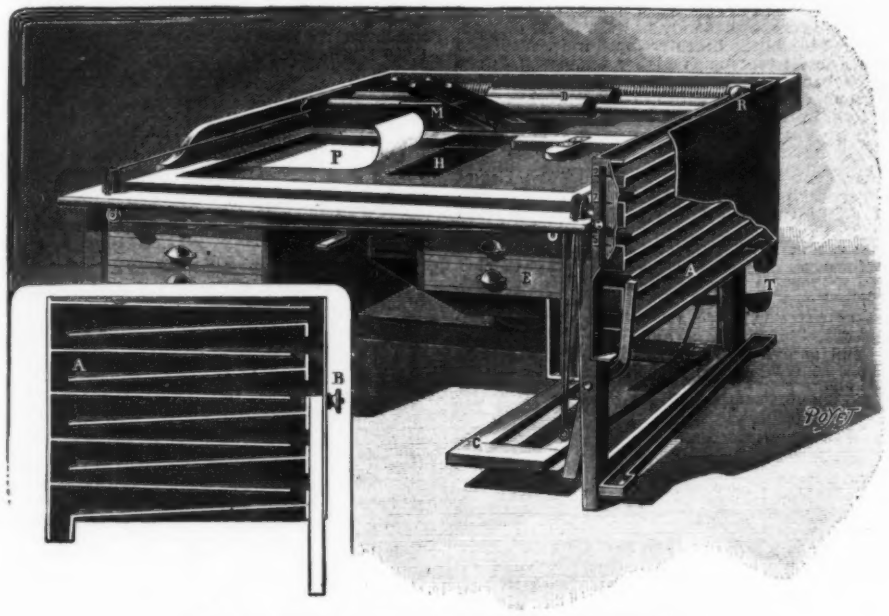
Opposite this aperture there is a space reserved for the placing of graders or plates of ground glass when it becomes necessary to soften the light. Beneath the aperture there is a mirror inclined at 45 deg. that reflects upward the light of a kerosene lamp inclosed in a lantern and evenly illuminates the negative.

The apparatus is, of course, placed in a room lighted solely by a red lantern. In the drawers with which it is provided are placed the negatives to be printed and the graders, etc. One of them is reserved for the unused paper, and another for the paper that has just been employed.

After the lamp has been lighted the shutter is maneuvered by hand in order that the operator may judge of the position of the negative and of the graders and ground-glass plates that have been selected. Then the operator closes the shutter, which is operated automatically. The paper, which measures 12 by 16 inches, is next put in place, and its position with respect to the negative is quickly fixed by means of a rule. The platen, *M*, is afterward turned down upon the paper and the pedal, *C*, is pressed. The descending motion of the latter carries along two rollers, *D*, that press against the platen and assure an intimate contact of the paper and negative. In addition, it opens the shutter located below and causes the fall of a steel ball, *R*, which rolls over a series of inclined planes, *A*, and, upon reaching the end of its travel, falls upon the extremity, *T*, of a lever, and, through its weight, frees the catch that closes the shutter. All that has to be done then is to allow the pedal to rise in order to liberate the paper, which is afterward shifted sufficiently to bring it into position for the next print. Such shifting is regulated in advance by the position of pins placed in a row along a rule. In order to determine the exact time of exposure one or two preliminary trials are made upon pieces of paper cut into the size of the negative, and after the desired result has been obtained the operator has no longer to occupy himself with the question.

Such result is obtained by the ingenious arrangement of the ball, which, at the will of the operator, may be made to traverse a path of varying length before falling upon the lever, *T*. It may be seen, in fact, from the detail view to the left of the engraving that by raising a rod, *B*, it is possible to offer the ball a varying number of inclined planes. When the pedal is operated the ball, as soon as the shutter is opened, falls directly upon *B*, and begins its travel at the point that has been selected for a given negative. It is then certain that for each operation exactly the same time will elapse between the opening and closing of the shutter.

After the entire sheet has been printed its development is effected, and as it is also upon this that may depend the tone of the image we are certain of having a uniform result for all the images of the same sheet —For the above particulars and the engraving we are indebted to La Nature.



THE MINERVA PHOTO-PRINTING APPARATUS.

MOTOR FIRE ENGINES AT GRÜNEWALD, BERLIN.

THE Paris Fire Department has fitted out all its vehicles with electric motors, and has thereby cut off the expense of feeding and stabling horses, and considerably increased the efficiency of the service. Following the example of Paris, the Volunteer Fire Department of Grünewald, near Berlin, has placed an order with a Berlin firm for a four-wheeled motor hose-cart. The entire equipment is to weigh 190 kilogrammes (418 pounds), and is to attain a speed of 1,000 meters in four seconds. The hose-cart is fitted with a knockdown hook and ladder, a life-net, hose, a life-line, smoke masks, and the usual implements of firemen. The wheels of the vehicle are fitted with pneumatic tires.

The fire department of Grünewald has for some time been using an improvised ambulance which has proved itself of considerable service. It is a four-wheeled vehicle and is drawn by a motor-tricycle driven by a benzine motor. The seat of the hose-wagon is a box in which bandages, medical appliances and small implements for first aid to the injured are stored. A foldable ladder is carried by the wagon, and between the legs of the angle formed by the ladder a reel of hose is mounted.—Illustrirte Zeitung.

[Continued from SUPPLEMENT, No. 1343, page 21522.]

THE PRESIDENTIAL ADDRESS OF JOSEPH WILSON SWAN, F.R.S., AT THE GLASGOW MEETING OF THE BRITISH ASSOCIATION.

HYPOCHLORITES.

As regards the production of hypochlorites, limits of space will only allow me to state that there are a very large number of firms in Europe using electrolysis for production of bleaching solutions containing sodium hypochlorite. The cells are patented under various names, and differ in details of construction, but the principle of the method employed is common to all, and depends upon the chemical action that takes place when chlorine gas is passed into a solution of sodium hydrate at a temperature below 20 deg. C. The solution obtained may contain up to 10 grms. available chlorine per liter. Bleaching liquids prepared in this way are being utilized in the textile and wood-pulp industries of the Continent to an increasing extent. The installations are in many cases small, and it is impossible to obtain details of all; but I am informed that 1,600 H. P. is being utilized in Southern Germany by one form of apparatus alone, so that the aggregate power utilized by the six different types must be comparatively large. One of the most notable installations of this kind is at Lancey, Isere, where Messrs. Corbin et Cie. are employing 700 H. P. for the bleaching of cellulose, using their own form of apparatus and cell. The Kellner-Partington Paper Pulp Company have also a large installation at Sarpsfos, in Norway.

CHLORATES.

The production of chlorates by the electrolysis of solutions of potassium or sodium chloride is one of the older electro-chemical industries, Gall and Montlaur having commenced to manufacture chlorates in this way on a small scale at Villers-sur-Hermes in France in 1889, and on a large scale at Vallorbe in Switzerland in 1890.

There are five different types of cell now in operation for production of electrolytic chlorates; but, as in the case of hypochlorites, the principle of the method employed is the same in all cases, and the differences are simply in details of cell construction. The diaphragm principle is still employed in the original process of Gall and Montlaur, but elsewhere this feature appears to have been abandoned.

The number of works producing chlorates by the electrolytic method is now ten, seven of these being in Europe and 28,000 H. P. is available for this manufacture. The prices of chlorate have fallen greatly since the electrolytic process was adopted on a large scale. Whereas ten years ago chlorate of potash was selling at 6 pence per pound, it is now quoted at only 3½ pence. The manufacture having become less remunerative, some of the electrolytic chlorate factories are being used for other products.

Before leaving this branch of my subject I may state that the manufacture of ammonium persulphate and perchlorate has now become a sub-branch of the electrolytic chlorate industry, and I am informed that these chemicals are being produced by Messrs. Corbin & Co. at Chedde, and by the Swedish Company at Mansboe.

In this case electrolysis has given a convenient method for producing compounds of high oxygen value, on a commercial scale. These products are used in photography, and in the manufacture of some of the modern high explosives.

ORGANIC PRODUCTS.

Besides the larger uses made of electricity in connection with the chemical processes I have spoken of, there is considerable experimental activity in the field of organic chemistry. Up to the present time it cannot be said that any very large or important section of the field is being successfully cultivated, but there is actual achievement of a substantial kind. In proof of this I give the following list of organic compounds, all of which have been produced in the chemical laboratory by aid of electrolytic methods. The first five have been produced in this way, I am informed, on a commercial scale, but I am not in a position to positively state that their manufacture by electrolysis is still continued.

Iodoform; vanillin; chloral; azo and hydrazo compounds; oxidation products of fusel oil; dyes of triphenylmethane type; aniline blue and aniline black; Hofmann violet; alizarine; Congo red; oxidation products of the alcohols; sulphonic acids; piperidine; dihydrochinoline; benzidine; amidophenol.

As these products are nearly all of industrial importance, it is possible that some of these methods may eventually be adopted for regular use.

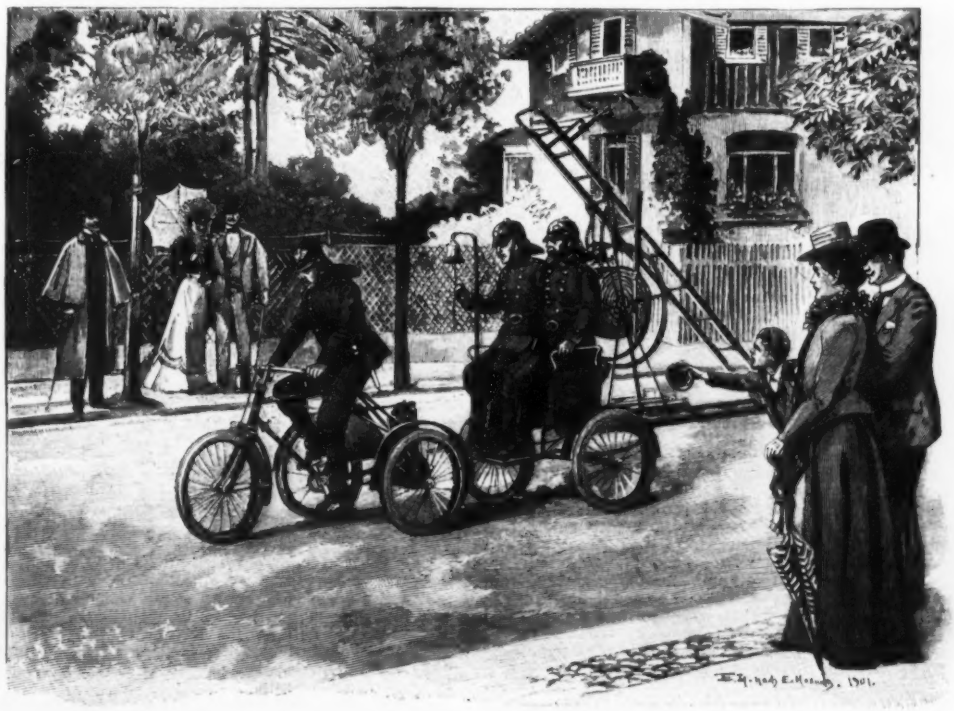
Messrs. Schering, of Berlin; the Badische Anilin und Soda Fabrik; Meister, Lucius und Brüning; and the Farbenfabrik vormals Fried. Bayer & Co. are all, I believe, using electrolytic methods, but definite information upon this point is lacking.

In all factories where organic products are made on a large scale, chromic acid is the usual oxidizing agent. Meister, Lucius und Brüning are now using an electrolytic process for renewing exhausted chromic solutions, and this process is said to have many advantages.

The electrolytic production of inorganic coloring matters has not developed into a recognized industry, but I am informed that there is a firm at Cologne producing white lead and other chemicals of this kind by electrolysis. Unfortunately I have not been able to obtain any details as to the extent or character of these products. In relation to the subject of electrolytic color making, it is an interesting reminiscence that so long ago as 1852, a patent for the production of colors as by-products in connection with the generation of electricity in a new form of voltaic cell, was granted to Watson and Slater, and that, about 1880, Goppelsroeder showed that indigo could be produced at the anode and reduced at the cathode of a voltaic cell.

OZONE.

The odor that pervades the atmosphere during a thunderstorm, due to the formation of ozone, is one of



MOTOR VEHICLES OF THE FIRE DEPARTMENT OF GRÜNEWALD, NEAR BERLIN.

the most ancient of observed electrical phenomena. It is not surprising that, with the large means we now possess of generating electricity and ozone, uses should have been sought and found for this powerful oxidizer. Accordingly we find that in the field of organic chemical manufacture it has been utilized with great effect, especially in the transformation of oil of cloves into vanillin and into heliotropine; also in bleaching operations in conjunction with hypochlorite of soda. Vanillin is produced by ozonization of iso-eugenol in acetic acid solution, and some of our members will no doubt remember with pleasure their visit last year to the works, near Paris, where this process is carried out. I am informed that the quantity manufactured yearly of these two valuable substances amounts to 10,000 kilos, and that 350 horse power (steam) is used in their production.

The ozonizer used at this works was designed by Verley. There are numerous types of ozone apparatus in use, and Otto Marmier and Abrahams, Siemens and Halske, and Andreoli have all patented particular forms that have received practical trial.

Among the more important uses proposed for ozone, the sterilization of water must be mentioned as occupying the attention of hygienic engineers. The principle of water sterilization by ozone has been definitely adopted for the water supply of Lille. The decoloration and defecation of syrup in the sugar manufacture, and the rapid production of the effect of "ageing" on alcohol, are among the many other uses proposed for electrically produced ozone.

THE FIXATION OF ATMOSPHERIC NITROGEN.

In close relationship to the electrical generation of ozone from atmospheric oxygen, is the important question of the production of nitric acid from atmospheric air.

At a Royal Society Soirée in 1892 Sir William Crookes exhibited the flame of burning nitrogen; and in the address given at the Bristol meeting of the British Association in 1898 he pointed out the great possibilities latent in atmospheric air as a source of nitrates for the fertilization of the soil.

Basing his calculations on figures given in a paper read before the Chemical Society by Lord Rayleigh in 1897, Sir William Crookes found that 14,000 B.T.U. would yield sufficient nitric acid to form one ton of nitrate of soda; and that at Niagara this quantity of power would not cost more than £5. Since then Messrs. McDougal and Howles have made further experiments, and obtained even better results. A full account of these experiments will be found in a memoir communicated to the Manchester Literary and Philosophical Society last year (No. XIII., vol. 44, part 5). The following is an extract from that paper, which gives the best results so far obtained:

"An experiment was conducted with a mixture of oxygen and nitrogen in the proportion of two to one. The gaseous mixture was passed through the apparatus at the usual rate. A quantity of acid almost double that previously obtained (that was when atmospheric air pure and simple was used), amounting to 590 grammes, was produced." With the same power and time, viz., 12-horse power hours, Lord Rayleigh's result was only 440 grammes.

The manufacture of nitrate of soda in this way is still undeveloped industrially. The idea is nevertheless alluring, for surely chemical science and chemical industry can be put to no higher or fitter use than to help to increase the fertility of our fields.

Those immense sources of motive power, the waterfalls of the world, which are now for the most part running to waste, require some great employment such as this, the production of nitric acid. If the quantity of nitric acid produced per kilowatt of power expended can be increased yet a little further—and such a development seems to be far from hopeless—this immense application of electricity would become profitable. The subject is certainly worthy of the serious attention of chemists.

THE ELECTRIC FURNACE.

I now come to a section of the subject of more recent date, and one that has forced itself into a position of great importance with surprising rapidity—the section in which, not the electrolytic, but the thermic power of electricity is operative.

We are largely indebted to the initiative of Sir William Siemens for the idea of turning the heat effect of electricity to practical account, so as to obtain chemical effects not otherwise possible. Sir William Siemens exhibited his electric furnace in action before the Society of Telegraph Engineers in June, 1880, and lucidly pointed out its many advantages. The employment of electricity in this way to generate extremely high temperatures has, within the last ten years, been greatly developed. Yet it may be anticipated with much confidence that the industrial use of the electric furnace has not nearly reached its practical limit, although for the moment there appears to be a check along at least one of the lines of operation, the result of over haste and excessive production. But in several directions progress is still being made.

Regarded from a narrow point of view, to carry on a chemical process by electric heating seems, at first sight, of all methods the most wasteful. As we all know, in generating heat electrically, so many energy-expending transformations have to be passed through, that only a small fraction of the whole energy expended is finally effective in the furnace.

Where the electrically produced heat is derived from steam power, there are, at the outset, the losses incidental to the transformation of heat energy into motive power. These losses amount to 85 per cent, and often more. Before the remaining effective 10 or 15 per cent is electrically re-transformed into heat through the operation of a dynamo, other losses, mechanical and electrical, have to be incurred, so that before the end is reached a still smaller fraction of the actual energy of the coal remains to be finally utilized. Hence, from a superficial consideration of the question, it might well be concluded that to carry on large chemical operations economically by electrically generated heat, was of all hopeless projects the most hopeless and extravagant; but on a close examination of the case it will be seen that there are many compensations for these great losses, the chief one being that when at last you have obtained your electrically produced heat, you obtain it in a form so convenient for applying to the exact place where it is wanted that, in many cases, the wasteful mode of production is more than compensated for. For example, in the reduction and distillation of zinc by the process in general use, it is not uncommon to consume five tons of fuel in producing from the ore one ton of metal. If the statement lately made in a foreign journal in relation to the electrical extraction of zinc be true (and I see no reason to doubt it), only two tons of fuel would be required if the power had been generated by an economically working steam engine employed to generate electricity, to be afterward transformed into heat and properly applied to the reduction of a mixture of calcined ore and carbon in the electric furnace.*

In the Presidential address delivered before the Society two years ago by Mr. Beilby, the great waste of heat common in our factories and in our houses was clearly pointed out. Wasteful of energy as the transformation of motive power into heat through electricity is, it is not so wasteful as are many of the ordinary chemical and metallurgical operations.

The electric furnace not only has the merit of making very good use of the heat developed in it, but it has the further merit that much higher temperatures are attainable than in ordinary furnaces; consequently a new group of high-temperature products has been brought within the range of industrial use by its means.

ELECTRIC FURNACE PRODUCTS.

The most conspicuous members of this new series of electro-chemical products are calcium carbide, carborundum, and artificial graphite. All these demand temperatures for their formation so high, that their industrial production is only possible by means of the electric furnace. There is also another class of electric-furnace products assuming importance at present, the class which, while not demanding the highest temperature of the electric furnace, yet requires a temperature exceedingly high; and in reaching, maintaining, and applying it, electric heating has several advantages. I refer to the reduction of the more refractory metals and their alloys.

In the hands of Moissan the electric furnace has proved a most effective instrument of chemical research. The results of his operations, as set forth in his treatise, "Le Four Electrique," and as illustrated at the Paris Exhibition by the large and splendid collection of new and rare products, were in striking contrast to the simplicity of the apparatus by which the results were achieved.

Calcium carbide, carborundum, and artificial graphite are, in their origin, as industrial products, all more or less accidental results of the experimental operation of the electric furnace. The way in which the new industries, the manufacture of carborundum and artificial graphite, have been built up in America by Acheson deserves our unstinted admiration. Useful as artificial graphite has already been found to be in electrolytic operations, it would not be surprising if even more important uses for it were yet to be found. Prof. Chandler, in his address last July, gave details of these two very interesting industries.

Chromium, tungsten, molybdenum, and titanium, and their alloys with iron, are, through the electric furnace, now for the first time producible in such quantities and with such economy, as to allow of their entering into the larger schemes of the mechanical engineer.

CALCIUM CARBIDE.

After electrolytic copper refining, there is no branch of electro-chemical industry so large as that of calcium carbide. I am credibly informed that the European production in 1900 was about 60,000 tons, and that works exist with power to produce three times this amount, if the demand and price warranted such an increase of production.

In nearly every case the power by which the electric heat is generated is derived from water, and, considering the smallness of British water power, the manufacture of carbide is a matter of less interest to ourselves than to some of our foreign confrères. The only considerable production of calcium carbide in Britain is at Foyers, where there is a factory for the production of between 2,000 and 3,000 tons a year.

As a convenient means of generating acetylene, calcium carbide is interesting to all technical chemists, and it is not improbable that it may play an important part as a reducing and carbon-carrying agent in metallurgy.

Of late there has been most serious disproportion between the supply and the demand, with the result that only those factories that are most favorably situated in relation to cost of power and raw material, and also cost of carriage of the product to the place of consumption, have been able to carry on the manufacture with profit. Calcium carbide is one of those products not well able to bear long and difficult carriage. Not only has the immediate cost of carriage to be considered, but also troublesome restrictions of freedom of transport. These restrictions tend to embarrass and lessen manufacture. The anticipations of an almost unlimited demand have not been realized, and there are in consequence many carbide works idle, with water running to waste; and fully equipped power-plants ready to be applied to some more immediately profitable use. Such use may possibly be found for some of them, in connection with an extension of the alkali and chlorine manufacture. New electro-metallurgical processes, such as those for the production of steel, ferro-manganese, ferro-chromium, ferro-silicon, or other alloys of the more refractory metals, which are either already in demand or which promise to supply new requirements, may also be taken up by these works.

CHROMIUM AND ITS ALLOYS.

The production of chromium and of chrome-iron at Essen by means of the Goldschmidt-Vautin process—indirectly dependent on an electro-chemical product (aluminium)—has already been mentioned. The Willson Company in America have also been producing ferro-chrome alloy by a direct electric furnace method, and in 1898 they were stated to be making 60 tons of this alloy per month.

Chromium is reported to be made at Bitterfeld, in Germany, and also by several of the French electro-metallurgical companies, but I have not been able to obtain any very reliable figures for the output of these works.

FERRO-SILICON.

Ferro-silicon is one of the newer class of alloys now being produced on a commercial scale by the electric furnace. At present the demand is small, and the production exceeds the requirements, but it is hoped that in time there may be a large demand for this alloy in connection with the manufacture of iron and steel. It has been proved that, where there is no excess of carbon, silicon improves some of the physical properties of steel, and that its thermal energy is of value in steel casting. Ferro-silicon is at present being manufactured at Meran, in the Austrian Tyrol, and at other carbide works in France.

Scrap iron, quartz, and coke are used as raw materials of the manufacture. The daily yield of each furnace is 1,200 kilos. The product contains 77.5 per cent Fe and 21.5 per cent Si, and costs at Meran 8 pounds per ton. The yield in the electric furnace is 1 ton per 5,000 kilowatt-hours.

FERRO-TITANIUM.

The manufacture of ferro-titanium is carried on at Niagara.

Scrap iron, titaniferous ore, and aluminium are heated together in a resistance furnace, and the product is sold for use in the manufacture of iron and steel.

Demand for this alloy has to be created; but it is expected that in time a large industry will be developed.

STEEL.

One of the latest and most startling developments in the field of electro-thermal applications, is the proposal to use electricity in the manufacture of steel direct from the ores of iron. The Stassano process, which has already received experimental trial near Rome, is about to be tested on a considerable scale at Darfo, in Northern Italy, where 1,500 horse power is available, and an output of 4,000 tons of steel per year is expected. In Switzerland and in Sweden also, the application of the electric furnace to the direct smelting of iron ores is being discussed. In the latter country it has been stated that a works is in actual operation, and is producing 10 tons per day; but I have not been able to obtain any confirmation of this report. I may, however, say that it seems to me that in those countries where coal and coke are extremely dear, and water-power, and hence electricity, are extremely cheap, it is conceivable that the electric furnace may, in exceptional circumstances, find a very limited economic employment in the reduction of iron ores.

PHOSPHORUS.

The manufacture of phosphorus, the last electro-thermal industry of which I shall speak, is another case where an old process has been modified and improved by the use of electricity.

I have not been able to obtain special information as to the production of phosphorus by works using the electric-furnace method. As in the case of sodium, it is probable that in a few years the older method of manufacturing phosphorus will be entirely superseded. In 1899 Tatlock stated that one-half of the phosphorus production of the world (estimated at 1,000 tons) was produced by the electric furnace, and now every country of importance possesses phosphorus works depending on the use of electricity. In this country the Readman furnace is in operation at Wednesfield, and uses about 500 horse power. Electric-furnace phosphorus works are also said to be operating at Niagara, Paris, Vernier, and Griesheim.

MISCELLANEOUS.

There remains to be noted a few miscellaneous uses of the electric current, which fall outside the classification I have adopted. One of the most interesting of these is the industrial production of oxygen and hydrogen by electrolysis of water. Several forms of cell have been patented, and are in actual operation at Rome, Brussels, Montbard, Toulouse, Milan, Zurich, Lucerne, Hanau, and other places. In most cases a solution of sodium hydrate is used as electrolyte, with sheet-iron electrodes; but in one instance a dilute sulphuric acid solution is employed, with lead electrodes. The cost of gases obtained in this way of course varies with the cost of power, but at Rome, where current generated at the Tivoli power station is utilized in this manufacture, 1 cubic meter hydrogen and ½ cubic meter oxygen are said to cost only 20 cents.

As the cost of hydrogen generated from zinc and sulphuric acid is stated by Schoop to be 2 shillings per cubic meter, the gain in economy is striking. Electrolytic hydrogen gas is used for inflating military balloons, and the two gases together are used for blowpipe and furnace work of all descriptions.

The application of electricity to tanning has been much discussed, but, so far as I can learn, only one system of electric tanning, that of Groth, is now in actual use. Groth's process is in operation at Wernersborg in Sweden, and at Wem in Shropshire. The system combines mechanical movement of the hides in the tanning pits, with electrolysis of the tan solution. Other large tanneries in Germany, Russia, and Austria are stated by the inventor to be about to adopt his system. The present capacity of the plant at Wem is 200 hides per week. The gain in time varies from half to two-thirds of that required by the older method, but some doubt still exists as to the durability of the finished leather.

Sugar refining by means of ozone has been already referred to. Other processes, however, have been tried (at Port Saint in France, and at Stefanowka in Russia), in which the destruction of the coloring matters in the sugar juice is brought about by electrolysis of the sirup, with zinc or aluminium electrodes. The results as regards color are good, but the economy of the method is not yet proved.

Finally, I must allude to the use of electricity in the chemical laboratory.

The following metals can be quantitatively determined by electrolytic methods:

Copper, nickel, cobalt, lead, antimony, bismuth, iron, zinc, cadmium, manganese, silver, mercury, tin, gold,

* Elettricita, Milan, September 22, 1900.

platinum, and palladium. The first six of these metals are, in fact, more quickly and conveniently determined in this way than by the ordinary gravimetric or volumetric methods of analysis.

Electrolysis can also be used with advantage to prepare standard acid solutions for volumetric analysis. Standard sulphuric acid is now being made in some laboratories by electrolysis of copper sulphate solution. The chemical laboratory of the present day cannot therefore be considered fully equipped, unless provided with the fittings and apparatus required for electrolytic work.

THE FUTURE.

So far I have spoken of the past and present; allow me now for a few moments to direct your thoughts to the future. We have seen that electricity has revolutionized the process of copper refining, made aluminium one of the common metals, and so far reduced the cost of sodium that new and large uses have been found for it, and dependent industries created. Electricity has successfully invaded the domain of the alkali and chlorine manufacture, and now threatens to encroach on the province of the blast furnace and the Bessemer converter, and to become an increasingly important factor in the reduction and treatment of metals in general. Are these achievements of the last decade of the nineteenth century but the prelude to still greater developments in the century upon which we have just entered, and will electricity become a yet greater power in the chemical and metallurgical processes of the future? This question requires earnest consideration; it involves interests of national importance, for chemical manufactures occupy, and have always occupied, a leading place among the industries of our country.

One of the larger questions brought into view by the prospect of a more extended use of electro-chemical processes, with their immediate dependence on power for the generation of electricity, is that of the position of those countries which possess coal, but do not possess waterfalls. Unfortunately, though we have an abundance of coal, we have very little water in the form available for the economical generation of motive power. Therefore the question comes home to us, whether with coal only, we can carry on electro-chemical industries with profit, in competition with the countries which possess a large supply of easily engineered water-power.

The question is complicated in many ways. In the first place it is necessary to find what is the cost of power developed by coal, and what the cost of power developed by water. The cost in neither case is uniform; the cost of water-power, and the cost of power generated by coal, both vary exceedingly, under different conditions. It is even a fact that water-power in some cases (no doubt exceptional cases) is more expensive than the power obtained from gas or steam.

The difference in cost in different circumstances is extremely great. From data gathered from many sources I find that there is one place (it is in Norway) where power is generated at a cost of 20 shillings per horse power year. This cost is chiefly interest on capital expenditure on the work. But, on the other hand, there are cases where water-power costs ten times, or more than ten times, this amount. The capital outlay at Lyons has been 84 pounds per horse power developed, as compared with 3l. 9s. 3d. at Vallorbe, in Switzerland. Niagara power is a mean between high and low water-power costs; there, the charge to large consumers is at the rate of 4 pounds per E. H. P. year.

Difference of cost is equally wide in the case of coal-produced power. I am informed on good authority that there are steam-power plants in operation in the United Kingdom which yield the power at a cost equivalent to 5 pounds per E. H. P. year; and certainly there are many where the cost will be twice and even four times that amount.

Such figures are for power generation on a large scale (not less than 1,000 horse power units), and also, of course, continuously and uniformly delivered. One other essential condition for obtaining a low cost for steam-power is, obviously, low-priced fuel. In the case where the E. H. P. year is said not to exceed 5 pounds, fuel cost only 4s. 10d. per ton delivered at the boilers.

But, notwithstanding the fact that under extremely favorable conditions electrical energy can be generated from coal at a comparatively low cost, the fact remains that the greater number of electro-chemical and electro-metallurgical plants are operated by water-power. Summarized, the returns sent to me show that fifty works in Europe have 149,000 horse power available from water, 16,700 horse power available from steam, and 250 horse power from gas.

In considering the bearing of these facts upon the actual position, it is to be borne in mind that the last word has not yet been spoken as to the cost of power developed by coal. Great advances have in recent years been made in the direction of reduction of cost, by improvements in the steam engine, the gas producer, and the gas engine. In the best modern steam engines a heat efficiency of 15 per cent is obtained. There is great reason for hope that help in the more economical generation of power for electro-chemical work may come from the further development of the gas engine. Already much has been done, both in the improvement of the gas engine and also in providing it with cheap gas. Our honored past President, Dr. Mond, has made a valuable contribution in this direction.

One of the drawbacks to the employment of gas engines for large operations has been that they were not adapted for large units of power, but now engines of 500 horse power and even 1,000 horse power are manufactured, and work with successful results.

Perhaps it is not wholly futile to inquire whether there is any other way of generating the electricity required for electro-chemical operations. The perfection to which dynamo-electric generators have been brought, both mechanically and electrically, is now so high, that almost the utmost possible limit of economy in the transformation of power to electricity has been reached. When there is put in comparison with this most convenient and effective means of generating electricity mechanically, the cost of obtaining the same results by the best chemical means now known, the question of displacing the mechanical method of generation, by the voltaic method, seems almost useless.

The difference is extreme. In comparing the cost of electricity produced by mechanical and chemical means it has been usual to emphasize the difference between the cost of coal and of zinc. But even if the high price of zinc were not a hindrance, and if zinc were as cheap as coal, or if it could be had for nothing, it would still be practically impossible to carry on the electro-chemical industries of the world by means of the voltaic cell as it exists to-day. The cost of the labor, and the complication of handling the gigantic cells, and keeping them in operation, would so far exceed the cost of producing electricity as we now produce it, that we should still continue to use the far more convenient water turbine, and steam engine, and dynamo, which yield us such great effects, with comparatively small apparatus, and with very little manual labor.

But that somewhat sweeping statement does not wholly dispose of the question, so far as it applies to the case in which cheap water power is unobtainable.

We know that the best of our heat engines utilizes but a small proportion of the potential energy resident in the fuel it consumes. Hence there is the possibility of a more economical way being found of transforming the heat energy of the fuel into electric energy, possibly even on the voltaic principle. But in order to obtain what is required that principle must be employed in a manner widely different from that hitherto attempted in the so-called carbon-consuming cells, or in any of the forms of cell where the electrolyte is a liquid, and the elements are plates that require renewal. I do not pretend to say how it can be done, or that it can be done in any way, but it seems to me that if there is a way in any direction, it is in the direction of a gas-consuming cell. A bold attempt at the solution of the problem in that way was made some years ago by Mond and Langer, when they produced a gas battery, on the principle of Grove's gas battery, that yielded a considerable current in proportion to its size, and consumed nothing but hydrogen and atmospheric oxygen. Unfortunately, since one of the essential materials in its construction was platinum, the apparatus, whatever its other merits, was too costly to be of practical use. There is one other attempt of the kind, which deserves to be remembered in this connection; I refer to the experiments of Kendall and his very ingenious gas cell, with fused glass as the electrolyte, and hydrogen and atmospheric oxygen as the source of energy. Here, too, the high price of platinum was an insurmountable bar to its practical utility.

For the present, it is to be feared and realized, that electricity cannot be generated in the British Islands by means of coal as cheaply as in those countries where abundant, accessible, and easily engineered water power is available, and hence it is necessary to consider what is best worth doing with the little water power and the more costly steam power or gas power at our disposal. Some of the new industries I have been discussing cannot be carried on with profit in our almost water-powerless island. Those industries, I mean, which use a great quantity of power in proportion to the value of the product. An extreme example would be the electric-furnace production of iron and steel, and the alloys of the more refractory metals. Such uses of electricity in this country are, in the present state of things, nearly out of the question. But I trust that gas engines, in conjunction with cheap gas, may ameliorate the situation, and that at no very distant date blast-furnace gases may be generally utilized for power production, in conjunction with some complementary or auxiliary electro-chemical manufacture. We cannot do everything, but it is certain that within the limits of our capacity there is yet ample scope for the profitable exercise of our energies. There are many electro-chemical industries in which the ratio of cost of power to value of product is such that the cost of power, at a rate which we know to be attainable in many of our manufacturing centers, is not prohibitive. We must concentrate our attention on these.

The alkali manufacture is in a state of unstable equilibrium. The electrolysis of brine from a commercial point of view must, under existing circumstances, be considered as a process for the production of chlorine rather than as a process for the production of alkali, because it is only to the extent equivalent to the chlorine required in commerce, either directly or incidentally to chemical operations, that soda can be manufactured by electrolysis as economically as by other means. Electrolytic soda must therefore be treated as the by-product, and chlorine as the principal product, of the electrolysis of chloride of sodium.

It is with the Le Blanc process chiefly that it comes into competition, to the extent to which the muriatic acid is used for chlorine generation, and that, of course, is to a very great extent. The scope of the one process is limited by the same disability as the other, viz., the demand for chlorine in some form; and that demand is, according to Dr. Lunge, only about one-eighth part of the demand for the equivalent of soda. But yet that one-eighth is a very large quantity, and within that limit, electrolytic production appears to have a fair prospect of commercial success, under favorable conditions.

Chemical industry is, almost beyond any other industry, liable to change. Twenty-five years ago we possessed well-nigh a monopoly of the manufacture and export of alkali. The Clyde, the Mersey, and the Tyne were the supply markets of the world for this typical and indispensable chemical product. We well know that that state of things no longer exists. The causes of the transformation are many, and most of them in the natural order of things. Taking a large and liberal view of the subject, they seem to be in the direction of progress, and for the general good; and yet it is a kind of progress in some respects detrimental to our interests, and not to be contemplated with perfect equanimity. Among what I term natural causes is the spread of knowledge, and especially such knowledge as we are so effectively helping to diffuse, a knowledge how to build, equip, and manage chemical works. Then, too, there is general increase of wealth abroad, and great development of commercial enterprise. But one of the less satisfactory of the causes of change, from the point of view of the British manufacturer, is that non-natural, that quite artificial, cause —prohibitive tariffs, the force of the principle of boycott. But that is a difficult and many-sided question, which cannot be discussed on this occasion. I mention it because it is necessary to explain, or partly explain, the falling off of our exports in heavy chemicals. And I suggest that probably the want of the open door has been one of the contributing causes.

Then there is the great question of education, in its bearing on the future prosperity of chemical industry, and industry in general. It was refreshing to hear from our late president how thoroughly the advantages of technological teaching, and education of the highest kind, are appreciated in America, and how generously educational institutions are supported.

Speaking in one of the lecture theaters of this great university, which has lately reverberated with the acclamations of the world in honor of its long and splendid services to education, I cannot but congratulate Scotland and the Scottish Section of the Society, on the very advantageous position it occupies in this respect. In England and Ireland we are suffering acutely from dire educational neglect and destitution, and that worst kind of poverty, *insensibility to our deficiencies.*

Our English system of scientific and technical education is not equal to the present needs of the country, seeing how severely we are pressed on every side by the most energetic and intelligent competition. We are giving to the classes at the bottom of the industrial ladder a disjointed smattering of miscellaneous science, of no great value, though probably good so far as it goes, while we are neglecting to thoroughly educate those upon whose shoulders will soon rest the weight of the management of our great manufacturing industries. In the present state of things a competent knowledge of the science of the business a man is engaged in, as well as an active interest in it, whether it be chemical industry or any other, are essential conditions of any large degree of success in meeting the emergencies of a highly competitive and progressive time. A scientific training of university standard, for our manufacturers and for our technical chiefs, is an absolute necessity. Surely public money cannot be better spent than in providing adequate facilities for the educational equipment of the men of the future, with this essential means of national defense. Our country possesses great stores of mineral wealth, a precious heritage that we are lavishly spending. That gift of nature will certainly not avert, and cannot go far to compensate for, the consequences of neglect of the scientific training, necessary to turn our fast diminishing mineral wealth to the best advantage.

One of the most pressing requirements of the moment, demanded not only in the interest of chemical industry, but in that of our manufacturing industries generally, is *adequate endowment and encouragement of research.* Original scientific research is the fountain-head of new knowledge, the vital stimulus of industrial growth, the originator of new industries and sustainer of old. Yet, nationally, in the organization of our educational and industrial system, we give to scientific research no hospitality—we barely pay it the respect of recognition.

The advance in knowledge, and the consequent revolutionary changes that have taken place in almost every branch of chemical industry during the last hundred years, are probably not greater than those further changes that will be seen at the end of the present century; for change, brought about by scientific discovery, grows ever swifter and more sweeping.

But change is in the natural order of things, and so long as it is in harmony with progress and improvement, it is to be welcomed—it cannot be resisted. We must prepare to meet it, and we had better meet it on the threshold. But to benefit by it, and to take complete advantage of it, demands the fullest measure of assistance that education, energy, and enterprise can unitedly give.

The chief object of our society, when it was founded, was to help the progress of the chemical industries of the country, by means of the interchange of technical information through association of its members and the publication of its Journal. It was an educational object, and it has in a large measure been realized. But now, after twenty years, at the beginning of a new decade and a new century, we see that the need of such assistance is no less urgent than at the outset, though happily the means and opportunities of help are greater than ever before. It rests with us to avail ourselves of them.

If, as we enter the darkness of the future, we firmly grasp the guiding hand of science, and, with full faith in her leading, follow her with an alert step, we may go on with the full assurance that we shall be led in the way of prosperity.

THE MINERALS OF MOROCCO.

ACCORDING to La Gazette Coloniale, Morocco is rich in various kinds of minerals. The most widely distributed are copper, lead, zinc, antimony, mercury and iron; also metals belonging to the platinum group—platinum, iridium, palladium, etc. In some places manganese and chromium have been discovered, and it is a well-known fact that Morocco possesses large beds of phosphate of lime. The copper ore is very often argentiferous, and sometimes auriferous, and is found everywhere in the region of Sous and of Tangier. Iron mines are numerous, and the presence of gold has been quite recently indicated. Lead ore, which is always more or less argentiferous, is frequently found in different parts of North Africa, though usually subordinate to the presence of other metals, as copper and zinc, in the same beds. The mines of Gar Rouban, on the frontier of Morocco, and veins cropping out in various parts of the Empire indicate the abundant presence of this metal.

Provincial Exposition at Malaga.—Consul Ridgely reports from Malaga that an exposition of the products of the Province of Malaga will be held in that city from August 17 to September 15. He adds:

"The Province of Malaga is one of the richest in Andalusia, and is famous for its wines, raisins, olives, figs, sugar cane, flowers, almonds, vegetables, and other products of semi-tropical Andalusia. There will also be a notable display of iron ore and other minerals."

THE LONGEVITY OF INSECTS.*

By Carus Sterne.

Delicate and frail as the body of an insect in many cases may appear, it very often shows a toughness and capability of resisting not only ordinary dangers, but also exceptional perils to a degree not often encountered in higher animals. Although for us who live in high latitudes, insects are "summer birds," creatures that pass the winter as larvæ or in nests, they are but little injured by cold when they have grown to maturity. A well-known example of this vitality are the so-called "editorial butterflies" which appear in the editorial rooms of every newspaper and magazine during the months of February and March as harbingers of spring. These insects are butterflies which have not propagated in their first summer and have crawled into some concealment in stables and houses, there to pass the winter half frozen, but still strong enough to fly out into the first warm day of early spring. Our *Vanessinæ* (tortoise-shell, peacock-butterflies, etc.) thus often enough become false heralds of spring. A search in the woods beneath the moss, in hollow trees, and holes in the ground will reveal swarms of fully developed insects, apparently in a perfect state of rigid hibernation; and these insects, upon the coming of the first warm day, are immediately resurrected. Many insects can even withstand the effects of being frozen in blocks of ice. DeGeer relates that he has seen frozen in blocks of ice insects which proved to be quite lively when the ice was melted. Réaumur has observed similar cases. The occurrence of butterflies in hailstones is also of interest. Dr. Zeller, during a hailstorm at Overdorf, near Salzburg, found a butterfly thus frozen in a hailstone. It was a male night peacock-butterfly, whose legs were buried several millimeters in the ice. Although apparently dead and completely rigid, the creature immediately revived after the melting of the ice.† Specimens of living insects completely inclosed in hailstones have also been brought to the notice of naturalists.

Living insects and their larvæ are often found in hot springs. Reeve found larvæ in the hot springs of Leuk in Wallis, the temperature of the water being 96 deg. C. Lord Bute found a swarm of small black bugs (*hydrocanthares*) in the waters of Albano, the temperature of the water being almost at the boiling point. These insects were so accustomed to the heat of their habitat that they soon died when placed in cold water. Kirby and Spence narrate that they once endeavored to kill a small wood beetle (*Lyctus juglandis*) by throwing it into hot water. After the insect had lain in the water for a time, to all appearances dead, it was removed. After having been dried it began to show signs of life.

That insects can withstand hunger follows almost as a matter of course from their power of hibernating during winter. But even under unfavorable conditions they often starve without any evil effects. Bugs of the species of *Curculionides* and *Pimelaries*, which have been preserved in collections and mounted on needles, showed signs of life after having been thus kept for months. Lacordaire states that he found a *Myctelia*, thus pierced, still alive at the end of seven months. In Volume XLI. of the Annual Reports of the New York State Museum, 1890, Dr. Fitch describes the case of various longicorns (*Chion cinctus*) which emerged from a table of applewood and which must have lived thus embedded for 20 to 28 years. He assumes that, as result of the air-tight inclosure produced by the varnish of the wood, the insects lived in a dormant state without any nutrition until life again appeared.

That insects are apparently uninjured by lack of air and by noxious gases and vapors must certainly have attracted the attention of many a collector who has endeavored to kill them by ether or chloroform, and found that they still persisted in living and that they very often escaped. Oswaldheer observed this power of resistance to nitrogen among the oldest of insects (clothes moths), which could not be killed even with sulphur fumes. He considers this power to be a heritage of the carboniferous age, in which the atmosphere still contained more nitrogen and carbon dioxide than oxygen.‡ An American entomologist recently made experiments for the purpose of determining the effect of various kinds of gases on insects. He found that flies, wasps, nightmoths and similar insects die in pure carbon dioxide or in hydrogen after ten or twenty minutes, whereas Colorado bugs soon revive, and are even able to resist the action of carbon monoxide and chlorine for three-quarters of an hour and more. Perhaps the insects which had apparently succumbed to hydrogen and carbon dioxide would also have revived. In order to kill them beyond the shadow of a doubt sulphur fumes must be used.

Even the ancients knew that insects could not be readily drowned. "If a fly falls in water," writes Ælian in his "Natural History" (II., 29), "it must eventually drown; for bold as the creature usually is it cannot swim. But if the dead body be taken out of the water and covered with ashes and laid in the sunshine the insect will soon revive." Ælian, of course, did not know that his insect was not really dead, and that it would have slowly revived without the aid of ashes. But the accelerating effect of ashes has often been demonstrated by the writer. It may possibly be that the alkali of the ashes may have some irritating effect; but perhaps the acceleration is due merely to a quicker absorption of the water from the spiracles.

Upon this phenomenon Lucian's pompous passage on the immortality of the fly's soul rests. Plato is censured because he has forgotten the immortality of his soul in his "Dialogues," and Lucian continues: "If a dead fly be strewed with ashes it is resurrected, and, like a new-born animal, begins to live its life again—a clear proof that the fly has an immortal soul; for this soul returns to the body which it left, recognizes it as its own and revisits it." Thus the tale of that Hermotimus of Klazomenæ is verified, of whom it is said that his soul often left him, and, after having wandered around the world for a time, returned to its body again. And thus Hermotimus had been held to be dead several times and had always revived again.

Hermotimus to all appearances evidently understood the art of the Indian Yogi, who throw themselves into a trance by self-hypnotism. But he was indiscreet enough to neglect to trust his body to the care of a trustworthy pupil; for his philosophical opponents, who would hear nothing of wandering souls, seized him one day and cut off his soul's return by quickly burning his body.

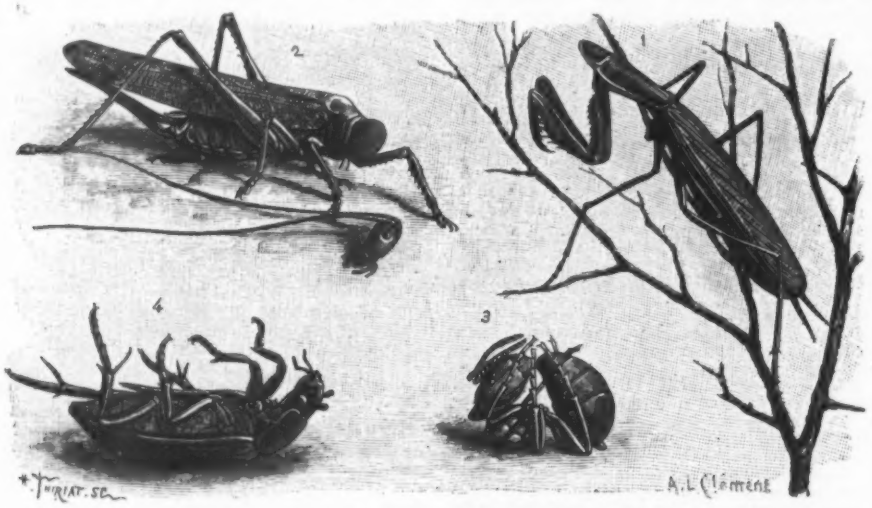
The French physiologist Deveaux has repeated the ancient experiments of asphyxiation by drowning, and found that ants have most remarkable powers of endurance.* The animal bends the body (Fig. 3) in such a manner that the posterior portion touches the mouth; it revives in five or ten minutes if submersion has lasted but a short time, and if it be laid upon blotting paper instead of being covered with an absorbent. After submersion of six or seven hours' duration ants again revive, although very slowly to be sure. After having lain in the sun for half an hour signs of life begin to appear; and after one and one-half hours the ants fully revive. After submersion of twenty-four hours most of Deveaux's ants revived; but the first movements, made after one-half to three-quarters of an hour upon exposure to the sun, were so slight that a magnifying glass had to be used. Reanimation was accelerated by slight irritation with a feather. But at the beginning only a feeble awakening, as from a dream, was observed, the insects falling again into their sleep and then reviving. Final reanimation followed alternations of trance and awakening.

Even after submersion of 50 or 60 hours some ants still revive and recover their former vitality. Others, after 3 or 4 hours, merely revive to the extent that they are capable of moving slightly, and die several hours later as a result of their long submersion. A return to life, very slight to be sure, but still distinctly observable, occurred in one of Deveaux's cases, in which an ant that had been submerged for five days gave marked signs of life, not, however, followed by complete reanimation.

It would seem that the resistibility to death would be most marked in water bugs. But, strange to say, Deveaux found these insects less capable of resisting long submersions than ants. The varieties of *Hydrophilus* and *Dyticus* (Fig. 4) when submerged for ten hours in a stream without being permitted to come to the surface did not fully revive. After a few seconds they moved their feet; but they died after two days without again coming to life. This remarkable result was attained in the case of a few specimens; other experiments were more successful.

The delicate leaf lice are less easily drowned than water bugs. Curtis saw four leaf lice revive after 16 hours' submersion, but failed to observe signs of life after 24 hours' submersion. Evidently the readiness with which insects come to life after having apparently drowned is the reason why the ancients ascribed immortality to their souls. To this theory of immortality Virgil also gives expression in his poem on the gnat (*Culex*). Even more remarkable than the power of resuscitation after drowning is the fact that insects revive after a spirit bath of not too long duration. One of the above-mentioned English entomologists, who were so closely allied with each other that it is impossible to tell whether Kirby or Spence is speaking, tells how he was attracted to entomology through this circumstance. "One morning," he narrates, "I observed at the window of my study a small yellow ladybird with twenty-two spots (*Coccinella 22 punctata*). You are very pretty, I said to myself, and I would be well pleased to have a whole collection of such creatures. I immediately captured my prize, and, since I did not know how to kill it, I threw it into a glass of brandy. Thus it remained for a day and a night, and since I saw that it made no motion I thought it dead and laid it into the sun to dry. Hardly had it felt the warmth when it began to move and flew away. From that time on I devoted myself to the study of insects." Long before him Swammerdam had observed that *Stratyomis Chamaeleon* revived after having lain an entire day in spirits of wine.

Most remarkable is the insensitiveness of many insects to vegetable poisons of all kinds. Many butterflies live exclusively from the foliage of highly poisonous plants. Many day and night moths live upon nightshade plants, asclepiades, and like varieties.



1. PRAYING CRICKET. 2. GREEN GRASSHOPPER (DECAPITATED). 3. RED ANT. 4. BROWN WATER-BUG (HYDROPHILUS), DROWNED.

* Prometheus.

† Meteorologische Zeitschrift, 1894, p. 294.

‡ Heer, Die Urwelt der Schweiz, pp. 83 and 84.

* Bulletin de la Société philomatique de Paris, 8 Série, Tome III.

THE INTELLIGENCE OF OUR WASPS.

By A. S. Packard, M.D., Ph.D.

This subject has been recently discussed in a beautifully-illustrated volume on the instincts and habits of the solitary wasps, by Mr. and Mrs. G. W. Peckham, so well known for their remarkable works on the habits of spiders and allied topics. Their studies were suggested by the attractive "Souvenirs Entomologiques" of a French naturalist, J. H. Fabre, but in some cases their conclusions differed radically from his, being based on different species, and also on a broader, more scientific way of looking at things.

As is well known, most of the solitary wasps sting, paralyze and store up in their deep tunnels spiders or caterpillars as food for their young. A favorite subject for observation was *Ammophila arenaria*, which uses caterpillars to store its nest. One was observed attacking a caterpillar. Notwithstanding the struggles of the worm, she finally lifted it from the ground, curved the end of her abdomen under its body and darted her sting between the third and fourth segments. The worm was paralyzed, limp and helpless. But, not content with this, withdrawing her sting she plunged it successively between the third and second, and between the second and first segments, and then left it lying on the ground. "For a moment the wasp circled above it, and then, descending, seized it again, further back this time, and with great deliberation and nicety of action gave it four more stings, beginning between the ninth and tenth segments and progressing backward." Then she rested, and smoothing her body with her long hind legs, washed her face with her fore-legs. Two other wasps of the same kind stung their prey in different places, and one of them adopted the process of *malaxation*, which consists in repeatedly squeezing the neck of the caterpillar between her jaws, turning it around and around so that all sides were equally affected. The wasp lays her egg on one side in the middle of the caterpillar. In making her nest she bores in the earth an inch deep, and then excavates a larger chamber or pocket, in which the caterpillars are stored. On closing up the hole the wasp wedges a good-sized piece of earth or a stone deep down into the neck of the burrow, filling the space above solidly with smaller stones and earth. In all cases the mode of closing and other details differ with different individuals. There seems considerable variation in their nestling instincts. In fact, in all the wasps the nature of the work differs with the individual. The most remarkable case was that of an *Ammophila* which used a little stone as a tool and made an intelligent use of it. She actually, after covering over her nest with her jaws, picked up a little pebble and used it as a hammer in pounding down the dirt with rapid strokes, thus making this spot as hard and firm as the surrounding surface. She did this not only once, but a second time. It might be doubted whether this should be credited, but a similar instance was observed and published some years ago by Dr. Williston, in Western Kansas, where an *Ammophila* flew to her hole, which she had just covered in, with a small pebble, "perhaps an eighth of an inch in diameter," in her jaws, which she used to press "down the dust all over and about the opening, smoothing off the surface, and accompanying the action with a peculiar rasping sound. After all this was done, and she spent several minutes each time in thus stamping the earth so that only a keen eye could detect any abrasion of the surface, she laid aside the little pebble and flew away, to be gone some minutes."

The striking fact ever present in all these actions and habits is variability. "Variability in every particular—in the shape of the nest, and the manner of digging it, in the condition of the nest (whether closed or open) when left temporarily, in the method of stinging the prey, in the degree of malaxation, in the manner of carrying the victim, in the way of closing the nest, and last, and most important of all, in the condition produced in the victim of the stinging, some of them dying and becoming 'veritable cadavers,' to use an expression of Fabre's, long before the larva is ready to begin on them, while others live long past the time at which they would have been attacked and destroyed if we had not interfered with the natural course of events. And all this variability we get from a study of nine wasps and fifteen caterpillars!"

As regards the stinging of the caterpillars and other insects stored up by the wasps as food for their young in hatching, it has always been supposed that the wasp had the wonderful instinct to aim the sting so as to penetrate the nervous ganglia, and thus paralyze the

victim, in order that the young larva might have living food. We do not see but that our authors have fairly shown that this may not be the case. No one has actually detected the wound of the wasp's sting in a ganglion. Our authors maintain that "the purpose of the stinging is not to paralyze and preserve the prey alive, since the wasp has no reason for attempting any such difficult procedure, for the larva thrives quite as well upon dead as upon living food." They believe that "the primary purpose of the stinging is to overcome resistance and to prevent the escape of the victims, and that incidentally some of them are killed and others are paralyzed." Thus one of the most cherished beliefs as to the wonderful and unerring instinct of these insects will have to be given up.

The Peckhams also confirm the observations of others that some of the solitary wasps have the remarkable habit of cutting off some or all of the legs of the spiders that they use for storing in their nests. If the legs were not removed, they would be too large for their coffin.

Another point about which there is now a decided difference of opinion is that of the "homing faculty" or "sense of direction" of insects. A recent German naturalist denies that ants and bees are guided by memory in returning to their homes, and thinks that they are guided by something like scent; hence the act, he thinks, is rather reflex than instinctive or rational. As our authors state: "The sight of a bee or wasp returning to its home, without hesitation or uncertainty, from some far distant spot is, indeed, marvelous. When we saw our first *Ammophila* perform this feat, we were filled with wonder." Our authors repeatedly saw different wasps study the locality about their nest, apparently observing the objects near, until they became so thoroughly acquainted with the topography that they could return directly to their nest. They claim that from their observations both of social and solitary wasps the homing faculty is not instinctive, but is the direct outcome of individual experience.

Finally they conclude that wasps act intelligently as well as instinctively; that acts which are instinctive in one species may be intelligent in another, while there is a considerable variation in the amount of intelligence displayed by different individuals of the same species. After many years spent in studies on the habits of insects they corroborate the view expressed by others, remarking that a single wasp, "uninfluenced in any way by the example of those about it, displays unusual intelligence in grappling with the affairs of life." They change their mode of nesting, all their changes being "intelligent adaptations to new modes of life, serving to keep the species in harmony with its surroundings." The work is published by the Wisconsin Geological and Natural History Survey, and from the painstaking and critical way in which the observations have been made, and the novelty and beauty of the plate, will remain a classical monograph.—The Independent.

A CAMPING OR MESS WAGON.

IT would be difficult to find a greater contrast than that between the prairie schooner and the camping or mess wagon which we illustrate, yet the latter is really an evolution of the first. It was designed by Major Stephen F. Hart and Dr. John A. Leighton, of New York. The wagon is used solely for the camping trips of these gentlemen, and enables them to take long tours and be entirely independent of hotels. The wagon is 11 feet long, 6½ feet wide and 10 feet high, and weighs 2,400 pounds. While two horses can easily draw it along ordinary roads, it has been found that traveling through a rough country can be expedited by using three horses. It has not been the custom of the parties who have used the wagon to ride therein, but rather upon saddle horses. If the horses were dispensed with comfortable accommodation for four people could be obtained in the wagon.

The arrangement of the interior will be understood by reference to the diagram. There are six lockers, each of a capacity of a good-sized dress-suit case. In these the personal belongings of the party are stored, doing away with the necessity of trunks and satchels.

The rear end of the wagon is allotted to the mess. Here all the cooking utensils are placed, together with such stores of the party which need not be kept in a particularly cool place. A compartment underneath the bed of the wagon, zinc-lined, serves as an icebox, and the adjoining compartment is available for icing beverages. At each meal the cover of the mess box at the rear end of the wagon is brought down to a horizontal position, being supported on each side by chains reaching from the wagon top down, the supported cover forming a table of comfortable proportions. This table is covered with an enameled cloth. The mess box thus exposed by letting down the cover forms a model sideboard for camping purposes. The mess box is large enough to contain all the necessary stores for six people for at least three weeks without replenishing, except eggs, dairy products and fresh meat, which may be procured along the route. When camp is made at night a canvas stretches from the top of the back of the wagon to the ground at an angle, forming a shelter 12 feet long and a trifle wider than the wagon body. The canvas also stretches in a similar way from the top of the wagon at each side for a space of 8 feet.

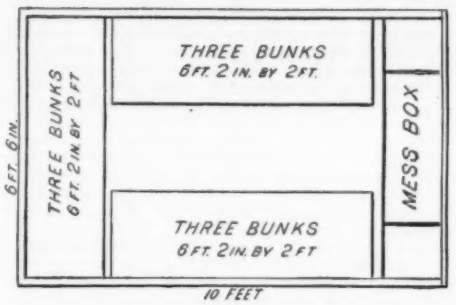


DIAGRAM OF CAMPING WAGON.

The sleeping arrangements are very ingenious. Iron rods reach from the top to the bottom of the interior of the wagon. On these rods slide six frameworks made of iron tubing on which the canvas is stretched. When ready for the night the arrangement is much like the berths of a sleeping car. Two of the berths are on each side of the interior of the wagon and two more at the front end usually occupied by the driver's seat. The latter berths are a trifle short, and they are assigned to the shortest members of the party. At present this is the only vehicle of the kind in existence, and it cost only $500 to build.

CAMPING WAGON DESIGNED TO ACCOMMODATE NINE PERSONS.

METHODS OF CURING TOBACCO.*

By MILTON WHITNEY, Chief of Division of Soils.

INTRODUCTION.

TOBACCO goes through certain processes of fermentation from the time it is cut until it is ready for the manufacturer. During this time it is said to be curing and aging. Very little is known about the chemical changes that occur in these processes. A great deal of work has been done by scientific men in studying them, but beyond the bare fact that they are similar to what goes on in wine and in the ripening of cream and the aging of cheese little has been discovered. It is a very important field of research and deserves a thorough investigation.

Upon the skill with which this curing and aging is managed depends in a large measure the value of the tobacco to the manufacturer. Farmers, as a rule, pay little attention to the matter and lose the profit that might otherwise be theirs. The curing comes usually when farm work in general is not pressing, and it is therefore the more deserving of attention.

Only general principles can be discussed in the present bulletin, for the minor details, however important in the work of handling tobacco, must be mastered by actual experience, under the supervision of an expert. The following suggestions will be found to apply to widely separated localities and to tobaccos intended for very different trades and uses.

* Farmers' Bulletin No. 60, U. S. Department of Agriculture.

CURING THE NORTHERN CIGAR TOBACCO.

Theoretically each tobacco plant in the cigar tobacco districts produces the filler, binder, and wrapper necessary for the manufacture of a cigar. The best leaves are to be used for wrappers, the second quality for binders, while the remaining leaves are for fillers. Practically, however, it takes leaves of very different qualities and properties to make the best filler and the best wrapper. A soil which will produce the best grade of wrapper is not likely to produce a filler of corresponding value. A soil which will produce a filler of fine quality will produce a wrapper leaf which is too heavy, strong, and dark for our present market demands. On account of the difference in the soils different grades of tobaccos are produced in the different northern tobacco districts. The main sorts of the Connecticut Valley crop are a wrapper and a binder leaf. This does not mean that good fillers are not raised on some of the soils of the Connecticut Valley, but the average soils at present used for tobacco produce a good wrapper leaf and a poor filler, as a rule.

On the other hand, the soils of the tobacco district of Ohio are very strong, heavy soils, containing a very high water content. These produce a strong, heavy, dark type of tobacco, which can be used at present only for filler purposes. The characteristic crop of Ohio used to be a wrapper, but in the change of style from dark to light cigars the produce of that district is adapted at present to the filler only. In Pennsylvania the same thing holds true, except that along the river courses the soils are lighter and a very fine quality of wrapper can be produced. The main dependence of the grower is a filler crop, and on the heaviest limestone soils filler leaf only is produced. The Wisconsin soils appear to come midway between the Connecticut Valley and the Pennsylvania soils, and both filler and wrapper are produced.

It is important that the distinction between the commercial requirements of the wrapper and the filler leaf be recognized; for under the present demands it is not only impossible to produce a wrapper and a filler of the same excellence upon the average soil of any of these Northern districts, but the treatment of the plant from the time it is set out until it is in the hands of the manufacturer should be different, depending upon whether the main object is to produce a wrapper or a filler leaf.

The crop is planted in rows, usually 3½ to 4 feet apart, and 18 to 24 inches apart in the row. It is topped to 15 or 18 leaves, and is frequently suckered during the season. It is on the ground about ninety days, the season averaging from about the middle of May to the last of August. All the leaves on a plant do not ripen at the same time. Under the conditions prevailing it is therefore usually considered necessary to determine the average time of ripening and cut the plant when the middle leaves are ripe. The ground leaves will of course be overripe, while the top leaves will have hardly matured. The stalk is cut and laid on the ground for one and one-half to two hours to wilt. It is turned, if necessary, to prevent burning. It is important that rain should not fall upon the plant while lying on the ground. After it is wilted sufficiently the stalk is speared on a lath, about eight plants to the lath. It is then hung in a barn to dry. The tobacco barn is quite tight but well provided with ventilators, which are opened on favorable days, as the barn must be well ventilated until the tobacco is thoroughly wilted. Artificial heat is not used. The time and rapidity of curing depends entirely upon the weather. It rarely exceeds two months, however.

When thoroughly dried the laths of tobacco are taken down during a warm, damp spell, and piled in heaps with sacks or cloths spread over them to keep the pile in "order" for several days. "Order" or "case" in tobacco curing means a moist condition in which the tissue will not break. Frequently when the piles begin to dry the butts are sprinkled with water. The stalks are taken from the laths and the leaves stripped off. The leaves are put by handfuls into a box lined with strong, tough paper. The paper is wrapped tightly over it and the bundle securely tied. A large proportion of the tobacco is sold to the dealers in this shape. Some producers sort it, however, and get 3 cents a pound more for it, although the packers usually re-sort it before the fermentation.

When properly sorted the tobacco is graded into fillers, binders, and long and short, bright and dark wrappers. These are made up into "hands," i.e., bundles of leaves tied together at the base. The tobacco is frequently "blown," that is, lightly sprinkled with water to bring it into proper order before casing or packing down, but this is never practised by the best farmers.

The fermentation, or sweating, is usually managed by the packers and not by the farmers. The sweating is done in wooden cases, strongly put together, holding on an average about 300 pounds of tobacco. These cases are not tight, but have a space of one-half inch between the boards. A good crop in sweating loses from 10 to 14 per cent of its weight, and there must be sufficient ventilation to allow this moisture to escape. On the bottom of the box is put a layer of top leaves, or seconds, as the outside does not sweat readily. The leaves are well shaken out and packed with the butts outside, and tightly pressed down to exclude the air as much as possible. The tobacco is piled into the box and pressed down with a moderate pressure, and then the top of the box is screwed on. The cases are then marked and piled up in the warehouse, in rows three or four boxes high, for the sweat. Once, at least, during the season good packers turn the boxes upside down and put the top boxes at the bottom.

The tobacco is cased in the fall or winter, and so remains through the next summer. The temperature of the warehouse is quite even during the winter. After the summer's sweat the operation is finished, and the cases are opened and sampled. This is one year after the harvest. After sampling the tobacco is returned to the case without breaking the bulk, and remains in the case until it is wanted by the cigar manufacturer.

The whole process of fermentation in this operation is largely a matter of chance. It is not controlled,

the temperature is not taken to note the progress of the fermentation, and nothing is done, in point of fact, except to maintain the temperature of the room moderately uniform during the winter season. In some cases the fermentation is overdone and in other cases it is underdone. There is a strong feeling among the more intelligent planters that more information is needed upon the changes which take place, in order that these may be carefully controlled.

There is room for marked improvement in grading and sorting the tobacco and putting it upon the market. Comparatively little attention is given to this subject, and as a consequence the cases when opened show various-sized leaves of various colors and shades. A profitable lesson can be learned from the methods of the Cuban and Sumatra growers. With them the tobacco is graded very strictly according to the length of leaf and the color and shade. The small manufacturer in buying a few bales is able to maintain a uniform brand of cigars. He is not able to do this with a small stock of domestic leaf, on account of the great variation in the color of the leaves.

CURING TOBACCO IN FLORIDA.

There are two important tobacco areas in Florida—the old area, in the northwestern part of the State, on the Lafayette clays, and the new area, in the center of the peninsula, around Ocala, Bartow, Fort Meade, and adjacent towns. The soil is quite different, but the tobacco is treated in essentially the same way in both localities. Both Cuban and Sumatra tobaccos are grown in the northern and western parts of the State, while mainly Cuban tobacco is grown in the peninsula.

The Sumatra tobacco is planted in rows 4 feet apart and 12 inches apart in the row. It is not topped until quite late and the field well in bloom, and from 24 to 26 leaves are left on the plant. This thick planting, and the large number of leaves left on the stalk, insures small leaves of thin texture. The tobacco is primed—that is, the leaves are gathered as they ripen. The harvesting is thus prolonged, and frequently lasts from June 15 to September 15, none of the leaves being taken off until they show signs of being ripe.

The Sumatra tobacco when planted early in the season is without spots, and makes what is known as the plain wrapper. When planted late it spots freely.

The Cuban tobacco is a smaller plant. The leaves are smaller and only about 12 or 15 are left on a plant. On the peninsula, especially at Fort Meade, a great deal of the tobacco land is irrigated by overhead sprays. It is claimed that this materially hastens the maturity of the crop, so that it ripens in from forty-five to fifty-five days from the date of setting out. It is usual to grow two or three sucker crops from each planting, and two main crops are planted each year—spring and fall. The sucker crop is not fit for wrappers as a rule, as it is too strong. It makes a good, strong filler.

The Cuban tobacco is harvested by cutting the whole plant and spearing on laths or by priming or by cutting the stalk in sections of two leaves each. In priming, the leaves are put into baskets and carried to the barn in covered wagons. They are then strung on strings tied to laths a finger width apart, making from 40 to 50 leaves on each lath. The laths are hung up in well-ventilated barns and allowed to dry. When thoroughly cured and the leaves are in proper case, or order, they are stripped off and tied into hands. These hands are then bulked for the sweat, the Cuban and Sumatra tobaccos being kept separate.

The bulks may be built up directly on the floor, or the leaves may be put into bins. In large establishments the temperature and humidity of the room can be thoroughly regulated to secure uniform progress of the fermentation. This is done by steam pipes to warm the room, in which there are vents for the escape of steam when it is desired to make the atmosphere more moist. The temperature of the room is kept quite high, and the vapor from the bulk which is being worked over is very pungent and almost overpowering. There is a very strong odor of ammonia, which makes it difficult to breathe.

The bulk is watched very closely, and as the temperature rises it is torn down, each hand of tobacco is taken up and shaken thoroughly to dry it a little, to cool it slightly, and to open the leaves so that they will not stick together. Before the sweat is completed the bulk is pulled down and built up eight or ten times, according to the condition of the tobacco. It is impossible, even for an expert curer, to give explicit directions as to when the bulk should be turned, as it depends entirely upon the condition of the tobacco and the temperature it attains, and these must be determined by the operator.

The temperature must rise gradually, and if it is found to be rising too rapidly, the bulk is torn down and a fresh one built up. Sometimes the bulk is not up over twenty-four hours before it is torn down again and built up afresh. If the tobacco is in high case, that is, quite moist, the bulks have to be turned over frequently in order to prevent too rapid action and to shake out the leaves which would otherwise stick together. If a bulk, as seldom happens, should dry out, it is turned over and mixed with a bulk which is in high case. The tobacco should never be sprinkled in this stage of the process to bring it into case.

The temperature of the pile is allowed to rise gradually until it occasionally reaches 180 degrees F. The fermentation is then at its highest. From this point the temperature subsides until the fermentation is complete and the bulk attains the normal temperature of the room. This maximum temperature must not be reached too quickly, and it must be managed differently with the different tobaccos. The fermentation must be carefully controlled, and not allowed to go too far with the wrapper leaf. With the filler, the further it goes and the more intense the action, the stronger and finer will the tobacco be for its purpose, if the work is judiciously done. As a matter of fact, it is not unusual to resweat the filler leaf to bring out the strong, rich properties which it is desired to develop. As the fermentation does not extend to the bottom of the pile, it is customary to put 8 or 10 inches of trash, which has already been sweated, on the bottom; and where bins are used a layer of trash is also put around the sides.

After the sweat the tobacco is brought into proper case and is then very carefully sorted. The wrapper leaf is sorted into four grades of light wrappers and four grades of dark wrappers, according to the length of the leaves. These are placed in small boxes on either side of the operator, and when a box is full the leaves are taken out and the Cuban tobacco is put up into "carottes" (cylindrical rolls). The carottes are made up into bales, similar in every way to the Cuban package, the wrappings being imported from Cuba for the purpose. The Sumatra wrappers are put up into bales similar in every way to the well-known form that is imported into this country in large quantities from Holland.

The filler leaves are frequently resweated and are usually petuned, a process which makes them very much heavier, darker, and stronger. The petuning is either done by spraying, which is the best way, or by dipping the tobacco. The essential part of the petuning liquid is a thick fusion of tobacco stems of the finest quality obtainable. To this is added, molasses, cider, Jamaica rum, or sour wine. Frequently other matters are put into the petuning liquid, according to the taste or fancy of the operator, to add quality to the leaf. This is a secret of the Cuban method and the only part of the process which they are unwilling to divulge.

When the petuning is done by dipping the tobacco, each hand is dipped separately, and is then thoroughly shaken, after which it must be bulked down to draw—that is, until the moisture has become thoroughly absorbed and evenly distributed through the leaves. Otherwise they would be apt to spot and change color. The wrappers are never treated in this way, as it is not desirable that they should have the properties of a good filler.

After the bales have been made up they are put into a warehouse in piles, not over three or four bales high, and should be kept at a moderately uniform and rather cool temperature at least two years, in order that the tobacco shall age, before it is suitable for making up into cigars. There seems to be no particular change that goes on, at least no noticeable outward change, as in the case of fermentation, but the tobacco loses the harshness that is always noticeable in fresh tobacco, and becomes mellow, as wines and liquors do by standing. When properly put up it will keep almost indefinitely in the bale, and the longer it is left to age the better it becomes.

There is no doubt that tobacco can be handled much better as well as more economically in large than in small quantities. The fermentation is much more uniform in large bulks than in small. If there are several bulks they can, if necessary, be mixed to insure the proper conditions. The different kinds of tobacco need to be treated differently, and this is only possible in case of a large quantity, where the selections will amount to enough to handle. With a large quantity of tobacco, also, it is possible to grade more carefully and more closely; and, lastly, it is always essential to have a large supply of tobacco of uniform quality in order that manufacturers may maintain any particular line of goods they may desire. For these reasons the farmers usually sell their crops from the field or from the barn to the larger producers or companies who maintain curing houses. It is claimed that not more than two per cent of the tobacco in the Gadsden district of western Florida remains in the hands of the farmers later than October 1. In southern Florida, also, it has been found more economical and more successful for the farmers to combine and have one large curing house, or to sell their product to the curing house rather than attempt to do the curing, grading, and sorting themselves.

CURING WHITE BURLEY TOBACCO.

White Burley tobacco is grown almost exclusively on the lower silurian limestone forming the blue grass region of Kentucky and Ohio. The plants are set out between May 15 and June 25, in rows about 3½ feet apart and 18 to 24 inches in the row. The season of growth averages about ninety days. The plants are topped to eighteen or twenty-two leaves and the lower leaves are pruned or picked off. When ripe the stalks are cut and split lengthwise and laid on the ground to wilt. They are then strung on sticks, four or six on a stick, and the sticks are hung on a low scaffold in the field. Within a week they are hauled into a well-ventilated barn, hung in tiers, and cured without the use of artificial heat. The process of curing must be gradual to produce a good and uniform color. This is regulated by the ventilator doors, according to the temperature and the humidity of the air. The crop can usually be cured in six weeks. The leaves are stripped from the stalk during the winter, graded as trash and lugs and bright, medium, and dark leaf. These are tied into hands and bulked down for a short time, after which they are "prized" into hogsheads. "Prizing" is pressing by power into the hogshead. The crop goes through a certain amount of fermentation in the bulk, and it must be examined occasionally to see that the temperature does not run too high. When it does, as seldom happens, if the tobacco is in good condition when it is put down, the bulk is turned over and a new one built up.

The manufacturers always rehandle and resweat Burley tobacco before using, and very little attention is therefore given to this process by the grower.

The White Burley tobacco when properly cured has a cherry-red or red-brown leaf of a mild flavor and great absorbing properties. The absorbing property makes it of especial value for the manufacture of sweet chewing plug. The lighter varieties, possessing little oil and gum, are used for smoking tobacco. On account of the absorbing properties and the importance of this in the manufacture of chewing tobacco, the tobacco must be prized rather dry in order to suit the market demand. By far the largest proportion of the White Burley tobacco is used in the domestic trade.

(To be continued.)

Office Mucilage.—Soak 3.5 kilos of white dextrin in 3.5 kilos of cold water. Next add 5.0 kilos of boiling water and boil for 5 minutes. Evaporate the clear solution down to about 7 kilos and add, after the cooling, 0.2 kilo of acetic acid (30 per cent), 0.3 kilo of glycerin, as well as a few drops of pure white carbolic acid for preservation.

SELECTED FORMULÆ.

Hard-Gloss Floor Oil.—

Melt together:

Siccative	5 parts
Linseed oil varnish, best	45 parts
Amber varnish	30 parts
Oil of turpentine	20 parts

Armature Paste for Black Harnesses.—

Carnauba wax	3.5 kilos
Japan wax	3.5 kilos
Ceresine	3.5 kilos
Oil of turpentine	38.0 kilos
Aniline black, fat-soluble	1.5 kilos

Melt the wax and ceresine; when lukewarm add the turpentine oil and aniline black and stir until cooled.

Yellow Leather Dressing.—

Yellow wax	2.0 kilos
Turpentine oil	4.0 kilos
Marseilles soap, scraped	0.2 kilo
Water	4.0 kilos

First melt the wax, next mix with the oil of turpentine, then add the hot soap solution gradually with constant stirring and continue stirring until the whole has cooled.

Instantaneous Gloss Blacking.—

Shellac, ruby	2.5 kilos
Camphor	0.3 kilo
Rosin powdered	0.5 kilo
Nigrosine	1.5 kilo
Methylic alcohol	20.0 kilos

Digest the ingredients with methylic alcohol in a closed vessel and draw off clear after complete solution.

Lubricating Oil for Bicycles, etc.—Below we give a receipt for a very excellent lubricant for wheels, which is thinly liquid and has the advantage over the lubricants formerly employed for this purpose of being free from all oxidizing ingredients, hence does not attack the bearings and other parts of the wheel. Furthermore it does not resinify and gum up the balls in the bearings and the teeth of the sprockets. It is prepared from 20 kilos of dried and crushed grapeseed and 40 kilos of ground-nuts, by cold pressure. The residue is now heated by steam, expressed again, and the oil obtained is allowed to cool and filtered. The resultant mixture of the grapeseed oil and ground-nut oil possesses a pleasant odor, is very liquid, but at the same time highly slippery and well qualified as a lubricant for bicycles, sewing machines, embroidering and knitting machines in place of the bone oil, neat's foot oil and white vaseline oil hitherto employed.

Glossing Agent for Starch.—Dissolve in the water at a moderate heat:

Water	10 liters
White glycerin (28 deg. Bé.)	0.6 kilo
Borax	0.3 kilo
Spermaceti	0.5 kilo
Gum arabic	0.3 kilo

The finished solution is filled in bottles. For use, add 1 tablespoonful of this preparation for 1 liter of ordinary, boiled starch, when starching.—Seifensieder Zeitung.

Preservation of Fruit Juices.—To preserve the juices of fruit by sterilization, put the juice into the bottles in which it is to be kept, filling them very nearly full; place the bottles, unstoppered, in a kettle filled with cold water, so arranging them on a wooden perforated "false bottom" or other like contrivance as to prevent their immediate contact with the metal, thus preventing unequal heating and possible fracture. Now heat the water, gradually raising the temperature to the boiling point, and maintain at that until the juice attains a boiling temperature; then close the bottles with perfectly-fitting corks, which have been kept immersed in boiling water for a short time before use.

The corks should not be fastened in any way, as, if the sterilization is not complete, fermentation and consequent explosion of the bottle might occur, unless the cork should be forced out.

The addition of sugar is not necessary to secure the success of the operation; in fact a small proportion would have no antiseptic effect.

If the juice is to be used for sirup as for use at the soda fountain, the best method is to make a concentrated sirup at once, using about 2 pounds of refined sugar to 1 pint of juice, dissolving by a gentle heat. The sirup may be made by simple agitation without heat and a finer flavor thus results, but its keeping quality would be uncertain.—Druggists' Circular.

To Preserve Lemon Juice.—There are several more or less reliable processes. The following has given satisfaction in our hands:

Express the juice and filter *at once*, through two thicknesses of best white Swedish paper, into a container that has been sterilized immediately before letting the juice run into it, by boiling water. The better plan is to take out of water in active ebullition at the moment you desire to use it. Have ready some long-necked 8-ounce vials, which should also be kept in boiling water until needed. Pour the juice into these, leaving room in the upper part of the body of the vial to receive a teaspoonful of the best olive oil. Pour the latter in so that it will trickle down the neck and form a layer on top of the juice, and close the neck with a wad of antiseptic cotton thrust into it in such manner that it does not touch the oil, and leaves room for the cork to be put in without touching it. Now cork, and cap or seal the vial, and put in a cool, dark place, and keep standing upright. If carried out faithfully, with due attention to cleanliness, this process will keep the juice in a perfectly natural condition for a very long time. The two essentials are the careful and *rapid* filtration, and the complete asepticization of the containers. Another process, in use in the French Navy, depends upon the rapid and careful filtering of the juice, and the addition of from 8 per cent to 10 per cent of alcohol.—National Druggist.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

German Trade in Musical Instruments.—The following is extracted from an article which recently appeared in the Zeitschrift für Instrumentenbau:

"The imports of musical instruments into Germany for the period from January 1 to April 30, 1901, compared with the same period of last year show an increase in pianos, music boxes, and zithers; the other branches have remained about the same.

"The imports of pianos increased from 33.18 tons to 38.58 tons, of which France furnished 20.83 tons against 14.77, and the United States 2.86 tons against 4.74 tons.

"The imports of harmoniums and organs amounted to 30.09 tons, 19.29 tons coming from the United States. The import of 15.32 tons of children's instruments is about the same as that of last year, Austria-Hungary furnishing 8.27 tons and France 3.75 tons. The imports of music boxes increased to 36 tons. Austria-Hungary furnished 11.46 and Switzerland 15.43 tons. The imports of accordions were 5.4 tons, Austria-Hungary furnishing 2.65 tons and France 1.21 tons. The imports of stringed instruments amounted to 17.86 tons; these instruments came almost entirely from Austria-Hungary. The imports of zithers increased from 6.5 tons last year to 12.57 tons for 1901, most of which came from the United States.

"The export of pianos increased from 4,152.25 tons for the first four months of 1900 to 4,385.61 tons for the same period of 1901. The export to Great Britain has increased about 19 per cent; that to Norway, Russia, England, Sweden, and the Argentine Republic has fallen off.

"The exports of harmoniums and organs have increased over last year by about 22 tons, this year's export being 152.12 tons. For these instruments, new markets have been found in the Netherlands, to which country 24.25 tons were exported. Austria-Hungary took 9.7 tons; Switzerland, 10.36 tons; Great Britain, 15.87 tons; and Russia, 23.48 tons. The export of music boxes amounted to 288 tons.

"The decrease in the export of accordions is over 7.7 per cent, the total being 695.66 tons. The loss was mainly in the United States trade.

"The exports of violins have fallen off from 99.09 to 93.03 tons. Those to the United States, however, show a material increase.

"In other stringed instruments Germany exported 10.47 tons, against 11.02 tons last year; the United States purchased 3.86 tons, against 3.08 tons last year; and Great Britain, 2.43 tons, against 2.09 tons.

"The export of zithers increased to 83.33 tons this year."—Brainard H. Warner, Jr., Consul at Leipzig.

American Salesmen in Great Britain.—The issue of June 29 of The Cycle Manufacturer and Dealer's Review, of London, has the following editorial:

"We believe we are right in saying that the American machines which are bidding for an English trade have not sold at all well this year. It is obviously well-nigh impossible to get at first hand facts, but scraps of information which have reached us, and sundry admissions in certain quarters all tend in the same direction—namely, that the American bicycle can only get a sale when it is very cheap. In our opinion, the Americans are slow to grasp the situation over here, and neglectful of the opportunities that present themselves. For instance, it may be taken for granted that an American machine takes a lot more push to sell it in England than an English machine of equal merit, and yet the advertising of the American machines over here has been absurd. In the first place, very little money has been allotted to advertising by the head offices in America, and then the style of advertisements has not been such as would be warranted to create a demand among the public. One firm took space in the public cycling paper, and in the proper course of events should have set themselves to prove to the public that the machine was worthy of confidence, that it was reliable and suited to English roads, that it was built to English requirements, and that it had many little points about it which placed it in the very front rank of cycles. In fact, this particular machine has a few taking points that are entirely absent from any English-made machine. Now, did the agency for this machine tell the public a word about all these things? Not a bit of it. They advertised that "the early bird catches the worm, and that there are few worms so fat as the agency for —— cycles;" and they repeated this advertisement for a couple of months, in spite of protests on the part of the paper that it could bring them no results. The advertisement might have been all right in a trade paper, but in a paper going to the public it was a sheer waste of money. This is the kind of thing that the Americans give us, and not unnaturally the business results are of a very limited nature. It is the same with accessories. American firms or agencies handling American goods have seldom done well, but when the British get hold of the goods, business is built up on right lines, and a big trade is done. The —— lamp is a case in point. When it was first introduced into this country, a big sale resulted from extensive advertising. Then, in order to increase the turnover, the American representatives went in for what they thought were smart moves in selling—planting firms with enormous quantities, giving "sole agencies" with the freedom of price lists, and so forth. The consequence not unnaturally was a flooding of the market with —— lamps at any price, in order to reduce stock, with the result that the lamp was ruined. Moreover, this sudden reduction of price frightened the public away. Afterward the agency was secured by the —— (a British concern), who ran it on right lines, and a trade is slowly being built up again, but there will for some time exist the suspicion that there may be a renewal of the former break in prices.

"With single-tube tires the Americans distinctly failed over here. We had the ——, the ——, the ——, the ——, and others, but in the first place the tires were not built to stand the amount of work which cyclists give their machines in this country, and in the second place a lot of low-class stuff was dumped down here and the single-tube tire earned for itself a shocking reputation. The American representatives were quite unable to meet the difficulties that presented themselves, and so went away in despair, leaving the —— Company to be formed by an Englishman, the goods to be made in America and suitable for our requirements, and for the business to be run on sound lines. The result has been that the single-tube tire is gradually getting a good hold of the trade, and a very sound business has been built up.

"About the only article that has been really well worked by an American, and which has steadily increased its trade from the day it was introduced into this country, has been the Morrow hub. But in this case the American at the head of affairs has had the gift of adaptability, and, quickly gaging the system of doing business here, has run his concern in a way that has brought the trade into his hands. But for this instance, we feel that we should be justified in saying that the British atmosphere quickly dulls the brightness of the Yankee, and causes him to run to rust. At any rate, those who have attempted to run their business on the American lines of 'selling for to-day and hang to-morrow' have all of them signally failed to do business with us."

The only comment I care to make on the editorial of the British bicycle paper as given above is that the editor assumes incorrectly that the mistakes he tells of in methods of selling were those of the American salesman. In nearly every case referred to I can almost say it is within my personal knowledge that the selling methods pursued were those stubbornly insisted upon by the American manufacturers, despite the protest of representatives whom they had personally selected to go abroad—men whose judgment has been much valued when they were in the home employment, but who found when they were abroad that practically no credence was given to their statements of the trade necessities here. Many a good American salesman has been recalled "in disgrace," and through no fault, but inability to unnecessarily force American merchant customs in foreign markets. The story of the American salesman in our new export effort as I, an American consul, could tell it, would not be pleasant reading. The wonder is they have accomplished so much, and I must confess I have about made up my mind to quit reading statements of our jumping statistics, for whatever are the totals they only touch the unbounded possibilities; no matter how they soar, there is waste in effort and failure to take full advantage of opportunity.

I have met hundreds of American salesmen since I have been consul here, and have had most pleasant relations and many friendly and confidential conversations with them. It is really a strange and unhappy fact that I have heard only three of these men express themselves as satisfied they have had proper home support. The case of one of these I will not mention. Of the other two who were satisfied, one is the son of the American principal and is given a good swing, but even his satisfaction hardly stood my cross-examination, and he left my office with a significant shake of the head, which I think I understand. The third man has been marvelously successful and naturally wants full credit for it, but admits he had a free hand, and that the opportunity to act as he thought best was due to the London partner of the business, who wrote repeatedly to his American associates demanding they keep hands off and not interfere with their American salesman here.

It is a fair assumption, if there be a good sale in England for American printing presses, American printing accessories, American printing inks, and even for American colored and fancy printed matter, that there is a general American printing superiority, yet an American representative in London for an American printing ink manufacturer was scolded because he asked that his ink samples be printed in America, as he could not get the same results here. He was told he must be a fool if he could not get good printing done in the largest printing center in the world, viz., London. If his principals had written that it would be better policy to sell their inks on the basis of English printed samples—because the American printed samples promised more than the English purchasers of the inks could accomplish with their best efforts—it would have been a business proposition; but even then it would have been advantageous to show side by side with them what splendid results were obtained with the same inks in America.—Marshal Halstead, Consul at Birmingham.

Electrical Developments in Greece.—The progress of communication within Greece at present is marked, and promises in the near future to bring conveniences of travel to a level with those of any country in Europe. The Greek Electric Company, otherwise known as the Thomson-Houston Company, established in 1898, with a capital stock of 10,000,000 drachmas* ($1,250,000), of which 5,000,000 drachmas ($625,000) is paid up, is now completing in Patras the first electric street railway in Greece, and, in fact, in the East. The same company operates the gas company of Patras, the electric light plants of Athens and Piræus, and four or more other cities, and is now negotiating with the Athens-Piræus Street Railway Company to supply motive power from a central electric station at Phalerum, near Athens. This proposed power station, if constructed, will be on a scale sufficiently large to supply power for manufacturing purposes, as well as for the lighting of Athens, Piræus, and Phalerum. It is also current rumor that the Franco-English company, already organized to construct a broad-gage railroad through the north of Greece to Athens, will soon begin operations. The completion of this road will connect Greece with the north of Europe by rail, and trains will be run from Paris to Athens direct via Constantinople.

Speaking more particularly of the street railway in Patras, the system will be similar to that found in general use in France and Italy. The road has been constructed entirely of iron and with considerable dispatch. The motive power will be furnished by gas motors of German construction. The steel rails are from Belgium, while from the United States there will come—from the General Electric Company, of New York—the material for the aerial line, insulators, circuit brakes, and car motors; and—from the John Brill Company—the trucks for the cars. The main stem of the road is constructed the length of the city, parallel with the sea, and extends some distance beyond the city limits, to a point suitable for coffee houses and baths. Business men generally believe the road will prove of great benefit to the city, but are skeptical as to the results to the company. It will probably be some time before the road will become a paying investment.—F. W. Jackson, Consul at Patras.

* The consul values the drachma at 12½ cents. This is the depreciated current paper drachma, for the United States Treasury values the gold and silver drachma at 19.3 cents.

The Mineral Treasures of Palestine.—Kirchoff's Technische Blätter has received the following communication from a German mining engineer in Palestine:

Valuable mineral treasures have recently been discovered in Palestine, so it is safe to say that the industrial awakening of the Holy Land is no longer a dream. It is true that the greater part of the once-flourishing country is a barren desert. The lines of communication are miserable and traffic is unsafe, aside from the one railroad from Yafa to Jerusalem.

The newly-discovered mineral deposits lie on both sides of the Jordan and the Dead Sea. The salt deposits of the Dead Sea could be developed into an industry. The waters hold chlormagnesium, brommagnesium, and calisalt. Aside from this, there are the bituminous chalk springs of Nebi Musa, which contain from 30 to 40 per cent asphalt.

The most important of all the deposits is phosphate. As is well known, natural calkphosphate, phosphorite, and coprolite are necessary for the production of superphosphates. This latter composition and sulphur form the most important ingredients in the preparation of artificial manure. At present, the phosphate mines of Florida almost supply the world's demand.

The immense fields of phosphate to the east and west of the Jordan need only better means of traffic and communication in order to insure their development. This, it would seem, is not far distant, as the Turkish government is planning a continuation of the Yafa-Jerusalem Railroad, and steamboats are already plying the Dead Sea.—Ernest L. Harris, Consular Agent at Eibenstock.

Machine for Extracting Maguey Fiber.—Consul Kindrick sends from Ciudad Juarez, August 9, 1901, a clipping from the Mexico Herald, as follows: "Señor Prieto, a Spaniard, who invented machines used successfully for extracting the fiber of the henequen plant or sisal grass in Yucatan, has just perfected a machine which promises to solve the long-pending problem of getting out the fiber of the maguey plant, which yields pulque, and grows on the Mexican table-lands in enormous quantities.

"Preliminary trials of this machine have been remarkably satisfactory, and specimens of the fiber sent to Europe are pronounced equal to henequen. German importers say that all the maguey fiber Mexico can produce will be taken at good prices. This means the building up of a large fiber export trade, and the utilization of a plant which, after yielding pulque, has had little or no commercial value. After the leaves have been stripped of the fiber, the residue makes an excellent food for cattle."

Belgian Demand for Hydrosilicate of Aluminium and Magnesium.—Vice and Acting Consul Van Hee writes from Ghent, July 24, 1901:

I have this day received a request from Jean Gorus-DeBlock, Chaussée de Bruxelles, Termonde, Belgium, for the names and addresses of manufacturers of hydrosilicate of aluminium and magnesium. These chemical products are now being imported into Belgium from Germany, but it is the desire of this firm to import direct from the United States. All correspondence, price lists, etc., pertaining thereto should be sent direct to the above address.

Venezuelan Tariff Changes.—Consul Plumacher reports from Maracaibo, August 2, 1901, that by an executive order of July 16, corn, beans, and peas have been placed on the free list from August 1 to September 30, to assist the poorer classes of population, who have suffered much of late from the high prices of articles of food.

Under date of July 25, Mr. Plumacher informed the Department that "oatmeal" had been placed in class 3 of the tariff (25 centimes, or 4.8 cents per 2.2046 pounds).

French School in Greece.—Consul Jackson reports from Patras, July 13, 1901:

The French government, through its Minister to Greece, has made the city of Patras a proposition to establish a French school here, and the proposition has been formally accepted by the Municipal Council. The French government asks the city of Patras to furnish a suitable building for the school; France will maintain the instructors, and the school will be known as the French Commercial and Agricultural School. The press of Patras and the people generally have considered the proposition in the most favorable light, but the final decision will rest with the government at Athens, and it is possible that the action of the Patras Council may be set aside.

The establishment of schools in Greece by other nations is not without precedent. The Italian government maintains schools for its subjects in Patras, and the Czar of Russia has erected baths at Athens in connection with the Soldiers' Hospital. The proposition of France, however, is without precedent, since in the other cases the entire expense has been borne by the government represented; while in this case the burden rests largely on the Greek taxpayers.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1140, September 16.—Self-Propelled Vehicles in Europe—New Viaduct at Luxemburg—Electrical Tramway and Lighting in Guayaquil—Butter in China—English Control of Russian Industries.

No. 1141, September 20.—Efforts to Save the Gutta-Percha Tree—New Bank in Nicaragua—The Pekin Syndicate—Briquettes from Garbage—Canadian Sales of Horses.

No. 1142, September 21.—Lignite and Peat Briquettes in Germany—Iron and Steel Manufacture in New South Wales—Frozen-Meat Exports of New Zealand.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Color Indicating the Temperature.—Carefully rub up mercuric iodide 100 and cupric iodide 100 with enough distilled water to form a paste of the consistency of paint. The color of this composition is red at ordinary temperature, but turns black at about 60 deg. C. and reacquires the red shade on cooling. The preparation is especially adapted to render the heating of parts of machinery perceptible in little accessible places.—Maler Zeitung.

Sauce for Cigars.—Into a bottle filled with ¼ liter of French brandy put 35 grammes of cascarilla bark and 35 grammes of vanilla previously ground with ½ pound of sugar; carefully close up the flask and distill in a warm place. After three days pour off the liquid and add ¼ liter of mastic extract. The finished cigars are moistened with this liquid, packed in boxes and preserved from air by a well-closed lid. They are said to acquire a pleasant flavor and mild strength through this treatment.—Apotheker Zeitung.

A New Lubricant.—We have had occasion to call attention to the advantages in the use of graphite as a lubricant. The Administration of Bavarian Railroads employs it under particular conditions which it is interesting to note. It is used for greasing the locomotives in the form of a solid product sold as a specialty under the name of "graphiol," which is composed of pure powdered graphite mixed in the proportion of 5 to 100 with thick oil; it does not decompose even at the highest temperatures, and loses none of its qualities. Moreover, its use is very economic; in fact, the cost of greasing was found to be no higher than 0.0074 franc per kilometer and locomotive, while the corresponding expense in the case of ordinary oil is 0.103 franc.—Moniteur de la Bijouterie et de l'Horlogerie.

Removal of Tattoo Marks.—The removal of tattooing was formerly considered impossible. Of late the following process is recommended: Apply a highly concentrated tannin solution on the tattooed places and treat them with the tattooing needle as the tattooer does. Next vigorously rub the places with a lunar caustic stick and allow the argentic nitrate to act for some time, until the tattooed portions have turned entirely black, then take off by dabbing. At first a silver tannate forms on the upper layers of the skin, which dyes the tattooing black; with slight symptoms of inflammation a scurf ensues which comes off after 14 to 16 days, leaving behind a reddish scar. The latter assumes the natural color of the skin after some time. The process is said to have given good results.—Neueste Erfindungen und Erfahrungen.

To Preserve Antique Metallic Objects.—The best process for the preservation of antique metallic articles, according to Asbrans, consists in a retransformation of the metallic oxides into metal by the electrolytic method. For this purpose a zinc strip is wound around the article and the latter is laid in a soda lye solution of 5 per cent, or suspended as the negative pole of a small battery in a potassium cyanide solution of 2 per cent. Where this method does not seem practicable it is advisable to edulcorate the objects in running water, in which operation fragile or easily destroyed articles may be protected by winding with gauze; next, they should be carefully dried, first in the air, then with moderate heat, and finally protected from further destruction by immersion in melted paraffine. A dry place is required for storing the articles, since paraffine is not perfectly impermeable to water in the shape of steam.—Der Metallarbeiter, Vienna.

Preservation of Zoological and Anatomical Preparations.—Some time ago Marpmann recommended sodium fluoride for the preservation of zoological and anatomical preparations. In pursuance thereof he publishes the following receipts, the use of which entirely does away with the now rather expensive alcohol. The process is as follows:

The preparations are first placed in a solution or mixture of—

Sodium fluoride	50 grammes
Formaldehyde (40 per cent)	20 grammes
Water	1 liter

After leaving this fixing liquid they are put in the following preservative solution:

Glycerin (28 deg. Bé.)	5 liters
Water	10 liters
Magnesium chloride	1 kilo
Sodium fluoride	0.2 kilo

In this liquid the zoological preparations, especially reptiles, retain their natural coloring. Most anatomical preparations likewise remain unchanged therein.—Zeitschrift für angewandte Mikroskopie.

Plastic Modeling Clay.—Repeated attempts have been made to substitute for the ordinary modeling clay a mass which remains permanently plastic, without its being necessary to keep it continually moist, as in the case of clay. Such preparations can be found in commerce, but they are very expensive and afflicted with very sensible faults.

It has also been attempted to add to the clay proper such substances as will render it enduringly plastic. The substances suitable for attaining this end, such as fats, oils, glycerin and similar bodies which do not dry or are slow drying, can be readily incorporated with clay, but do not furnish a mass of lasting plasticity, since the said admixtures decompose in course of time, thus rendering the mass unfit for use.

The new process is said to enable one to obtain a permanently plastic clay by first mixing it in the usual way with glycerin, turpentine or similar bodies and then adding vaselin or petroleum residues rich in vaselin.

The proportion of clay to the vaselin fluctuates according to the desired consistency of the product, the admixture of vaselin varying from 10 to 50 per cent. It is obvious that the hardness of the material decreases with the amount of vaselin added, so that the one richest in vaselin will be the softest. By the use of various varieties of clay and the suitable choice of admixtures, the plasticity as well as the color of the mass may be varied within fixed lines.—Maler Zeitung.

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TABLE OF CONTENTS.

PAGE

I. AGRICULTURE.—Methods of Curing Tobacco.—By MILTON WHITNEY. 21547

II. ARCHITECTURE.—The Building of Model Tenements. 21537

III. AUTOMOBILES.—Motor Fire Engines at Grunewald, Berlin.—1 illustration. 21540

IV. CHEMISTRY.—The Presidential Address of Joseph Wilson Swan, F.R.S., at the Glasgow Meeting of the British Association. 21543

V. COMMERCE.—Trade Suggestions from United States Consuls. 21540

VI. ELECTRICITY.—Contemporary Electrical Science. 21541
The Sprague Trains.—2 illustrations. 21542

VII. FUELS.—Kerosene Oil Blowpipe. 21537

VIII. HYDRAULICS.—Air Lift Pump.—1 illustration. 21539
Buffalo Water Works. 21538

IX. LOCOMOTIVE ENGINEERING.—American Locomotives in England.—V.—By a Locomotive Engineer. 21536

X. MECHANICS.—Some Motions, Relative and Absolute.—By OBERLIN SMITH.—6 illustrations. 21540

XI. MECHANICAL ENGINEERING.—Use of Blast Furnace Gas in Explosion Motors.—6 illustrations. 21539

XII. MINERALOGY.—The Minerals of Morocco. 21545

XIII. MISCELLANEOUS.—A Camping or Mess Wagon—2 illustrations. 21547
Selected Formulæ. 21545
Trade Notes and Receipts. 21550

XIV. NATURAL HISTORY.—The Intelligence of Our Wasps.—By A. S. PACKARD. 21546
The Longevity of Insects.—By CARUS STERNE.—4 illustrations. 21546

XV. PHOTOGRAPHY.—New Method of Photo-printing.—1 illustration. 21542

XVI. STEAM ENGINEERING.—Penman's Water-tube Boiler.—3 illustrations. 21539

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